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Tanaka et al.

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(54) **IMAGE HEATING APPARATUS**

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G03G 15/20 (2006.01)

(52) **U.S. Cl.** **399/327**; 399/331

(58) **Field of Classification Search** 399/325, 399/326, 327, 330, 331, 335; 219/216
See application file for complete search history.

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(57) **ABSTRACT**

An image heating apparatus includes a contact-sliding member parallel to a generatrix of a heating roller and brought into contact with the heating roller configured to heat a toner image on a recording material. An inlet space and an outlet space are formed at the upstream and downstream ends, respectively, of a contact area. A cleaning member, provided on the downstream side of the contact area, cleans the surface of the heating roller to remove toner and paper dust from the surface of the heating roller.

2 Claims, 16 Drawing Sheets

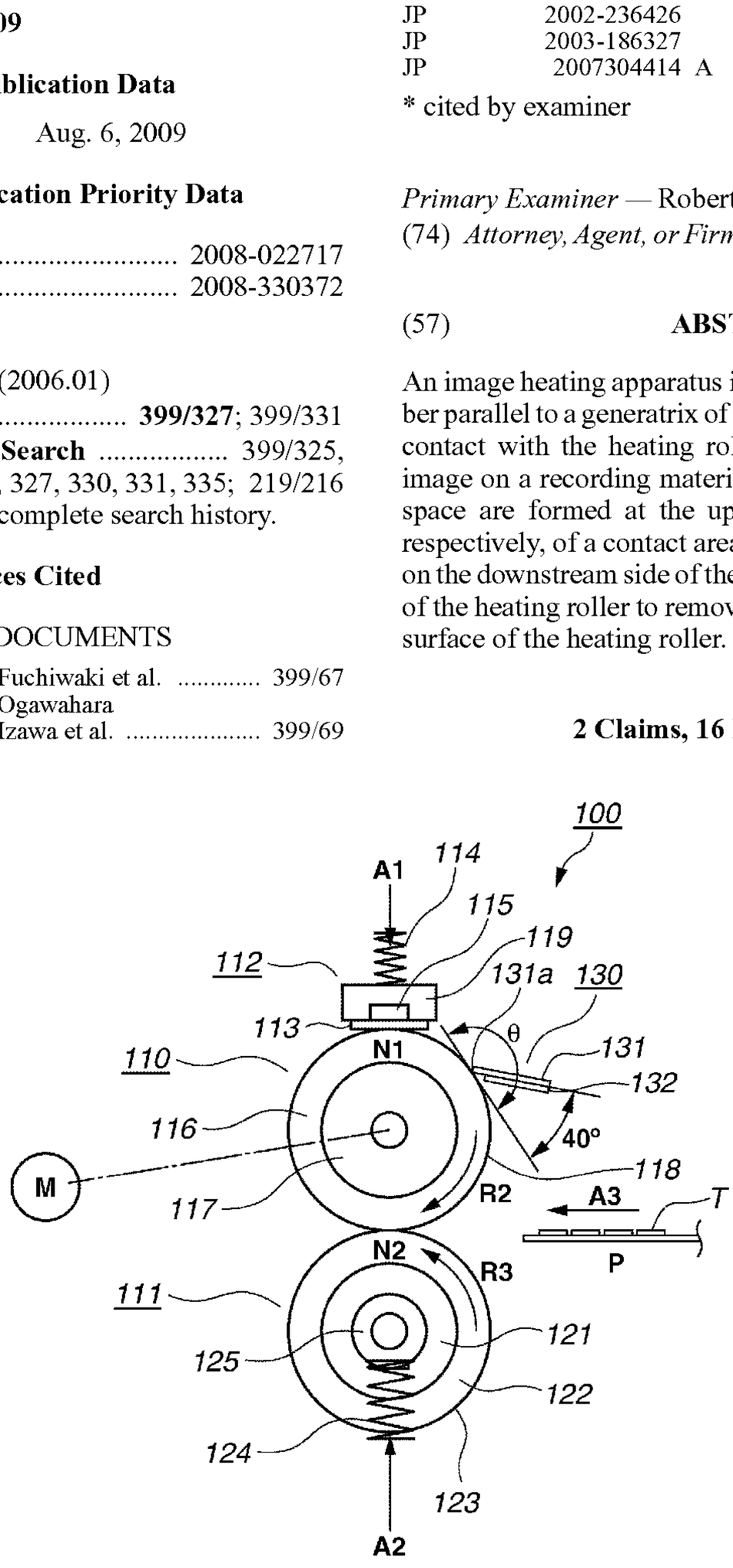
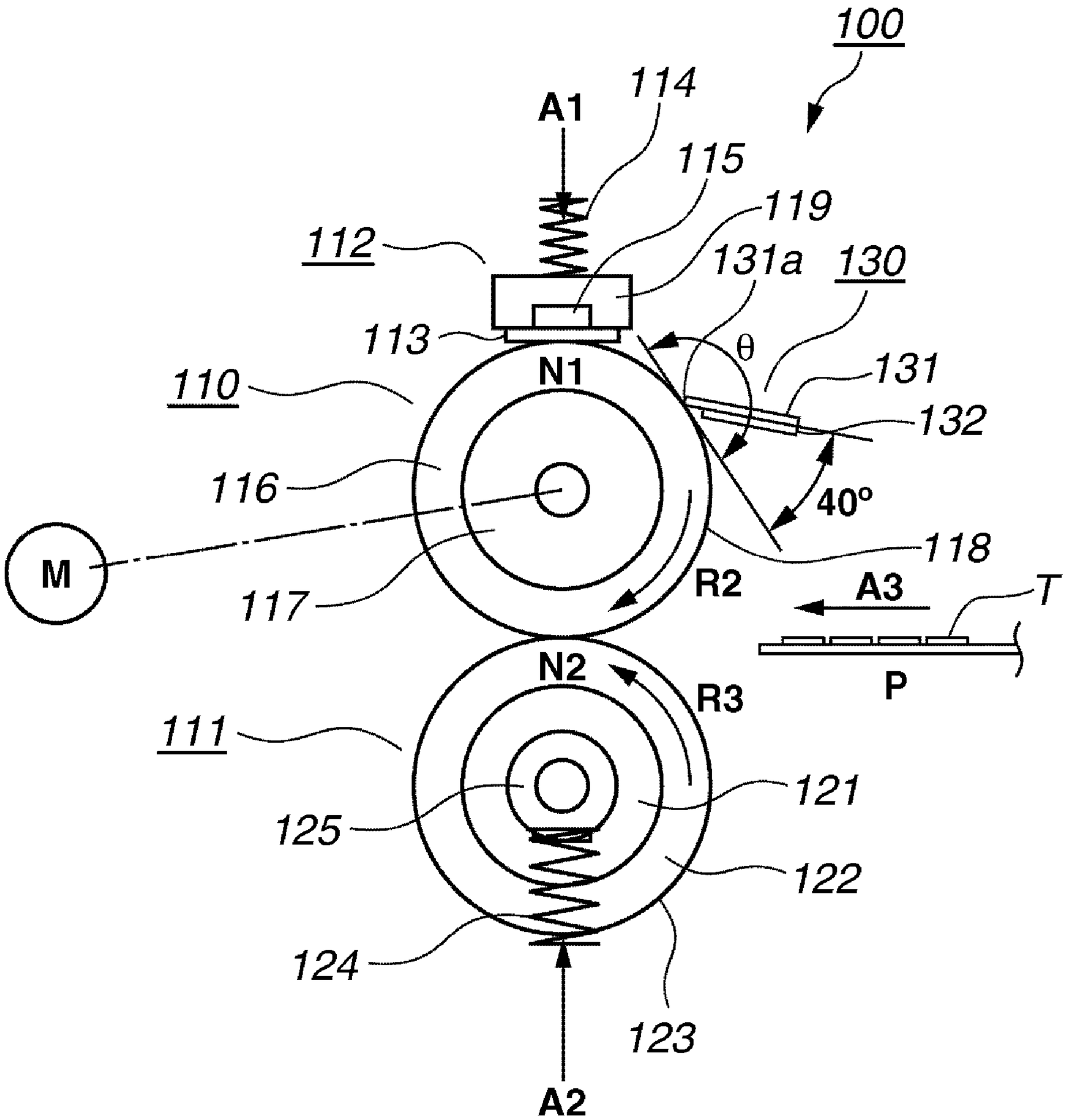


FIG.1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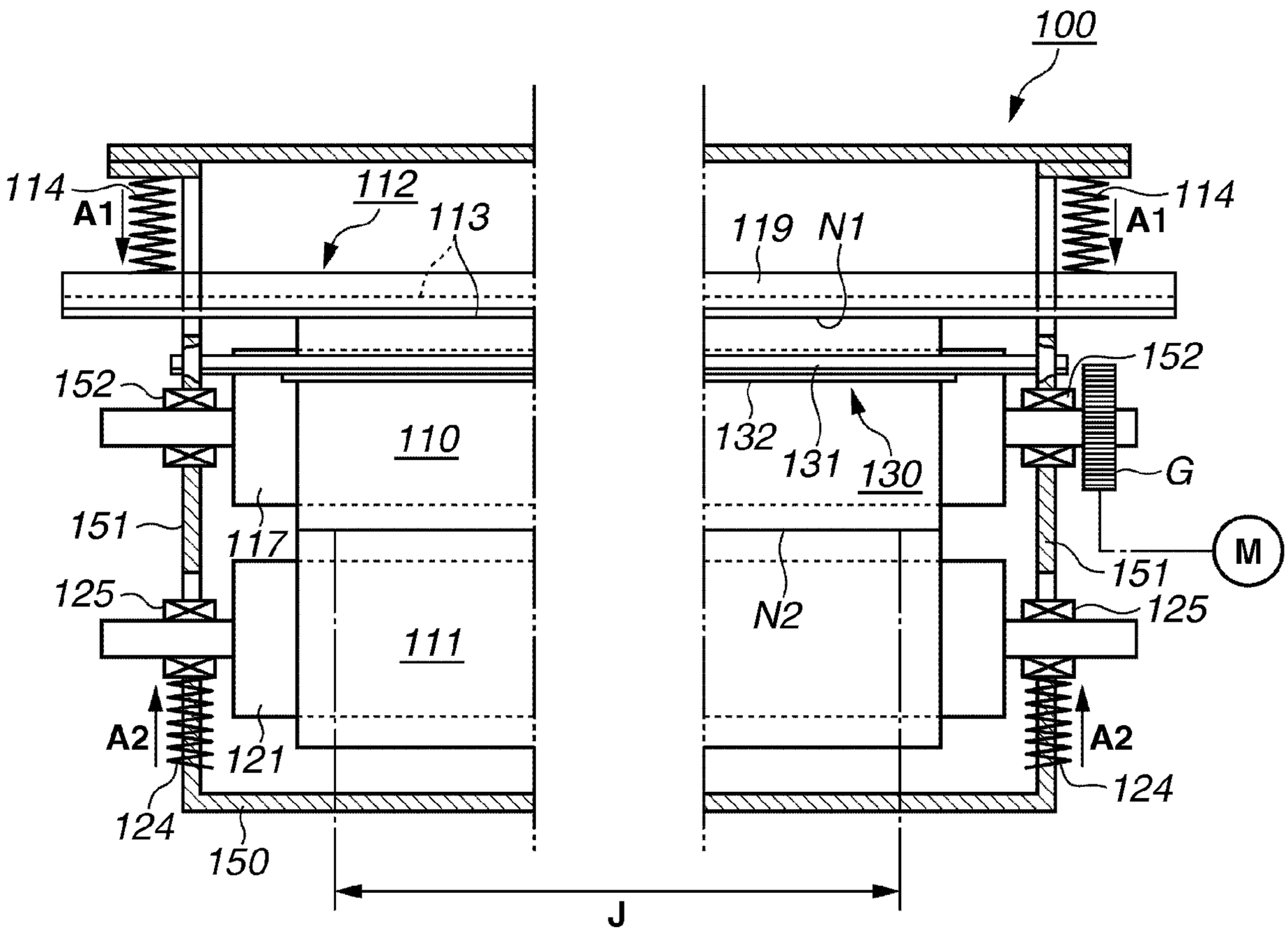
A1
114
115
119
112
131a
130
113
θ
N1
110
131
132
116
40°
M
118
117
R2
A3
T
N2
P
R3
111
121
125
122
124
123
A2

FIG.2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131
130
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A2
121
A2
124
124
150
J

FIG.3

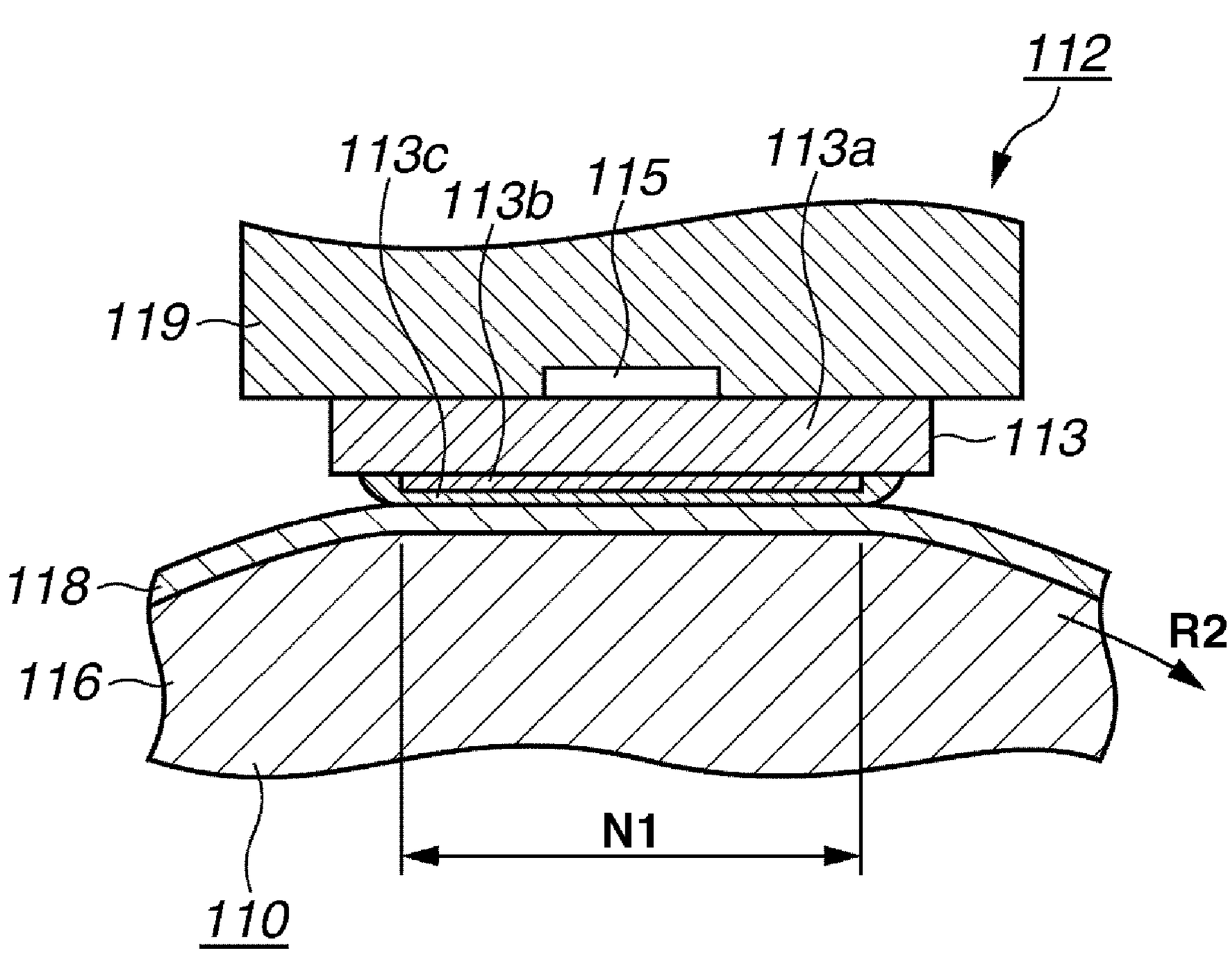


FIG.4

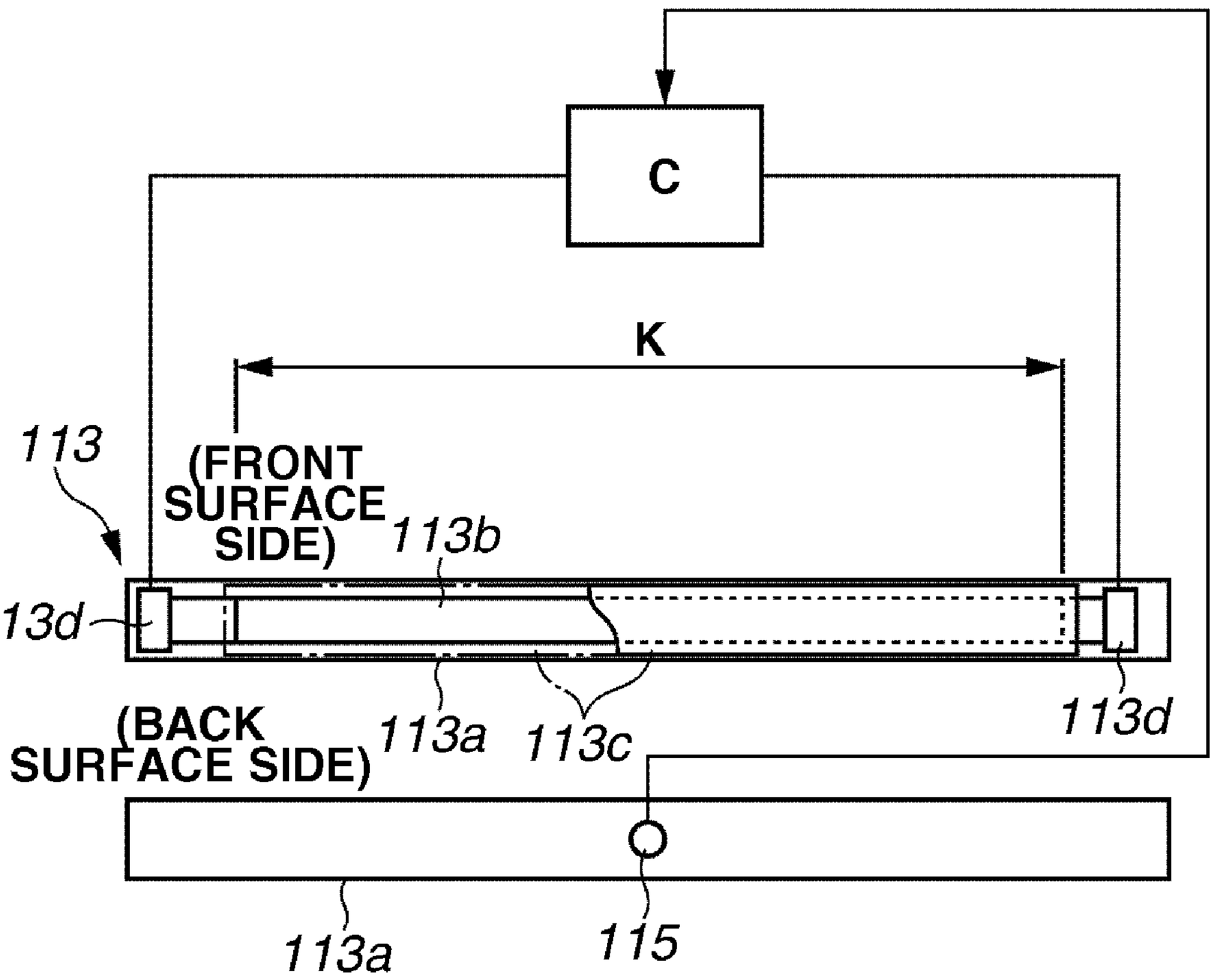

C
K
113
(FRONT SURFACE SIDE)
113b
113d
(BACK SURFACE SIDE)
113a
113c
113d
113a
115

FIG.5

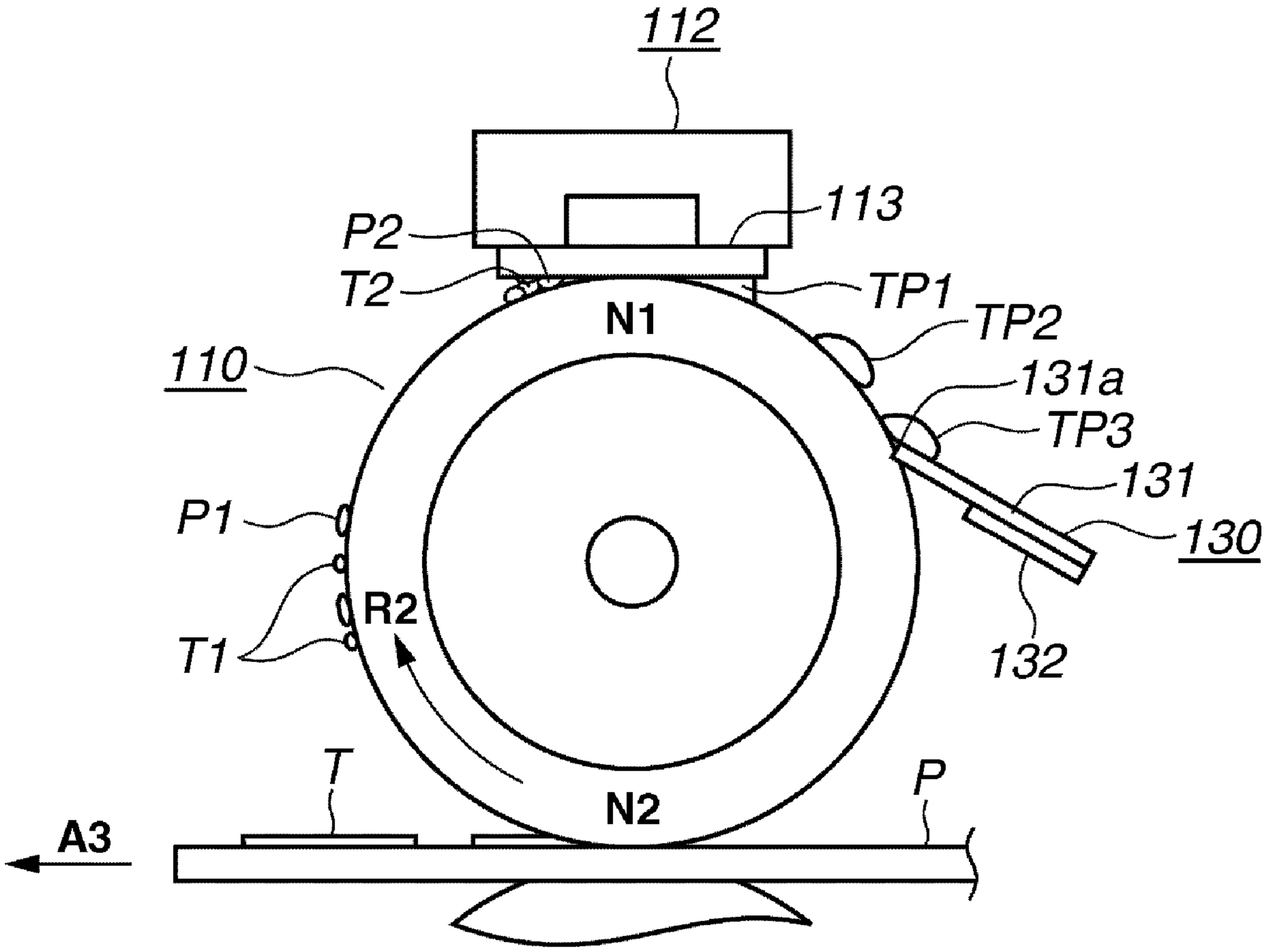


FIG.6

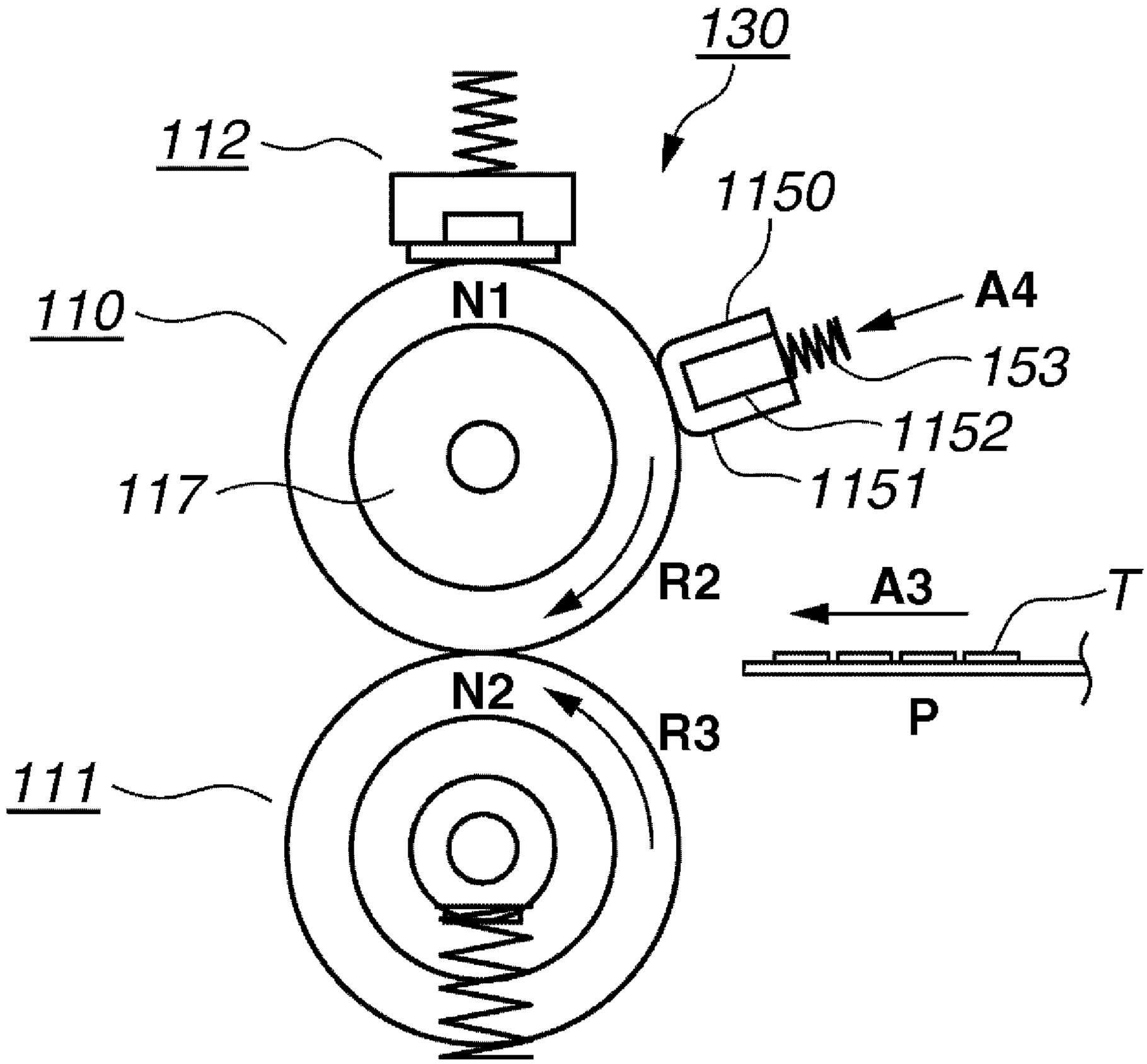


FIG.7

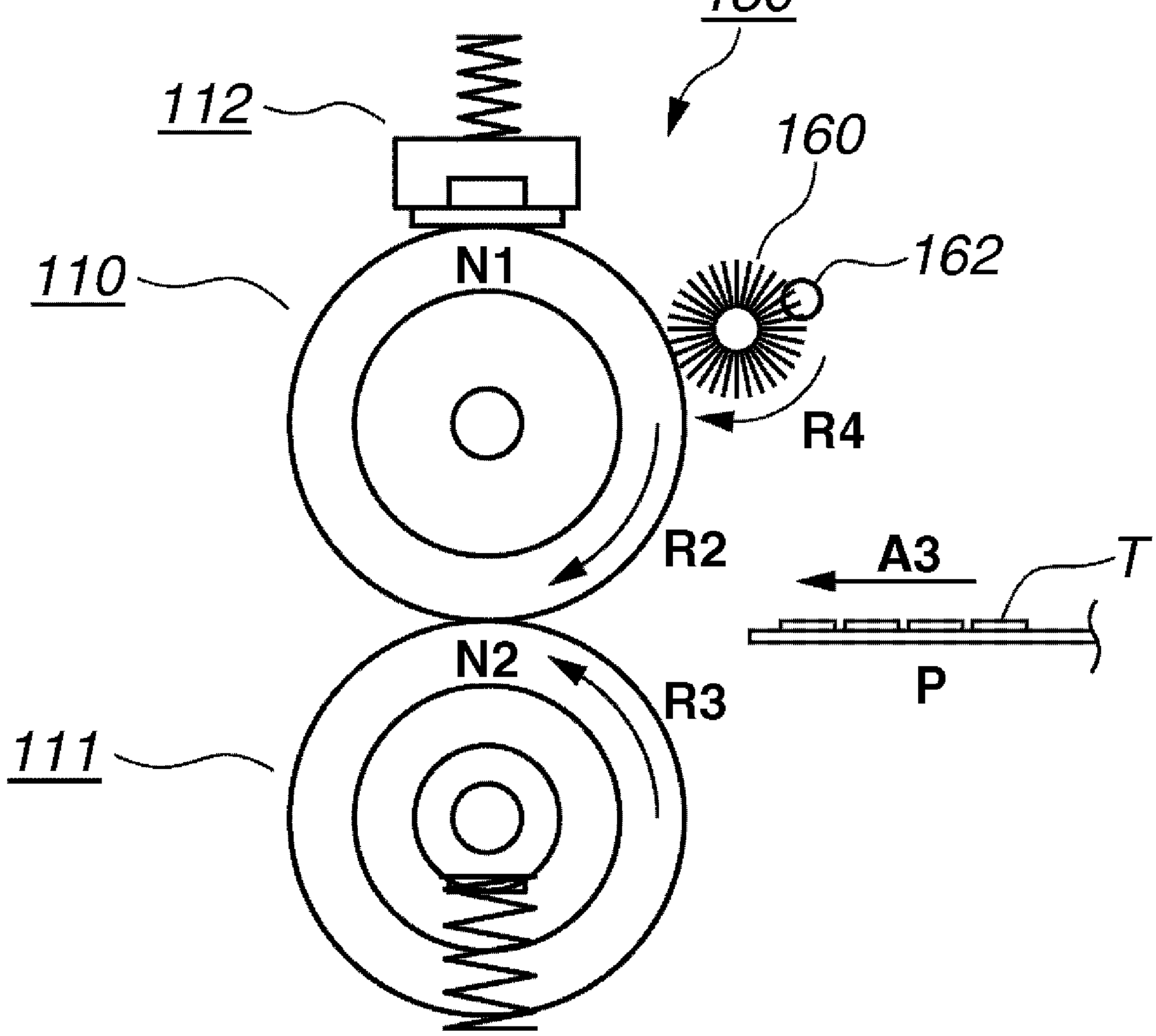
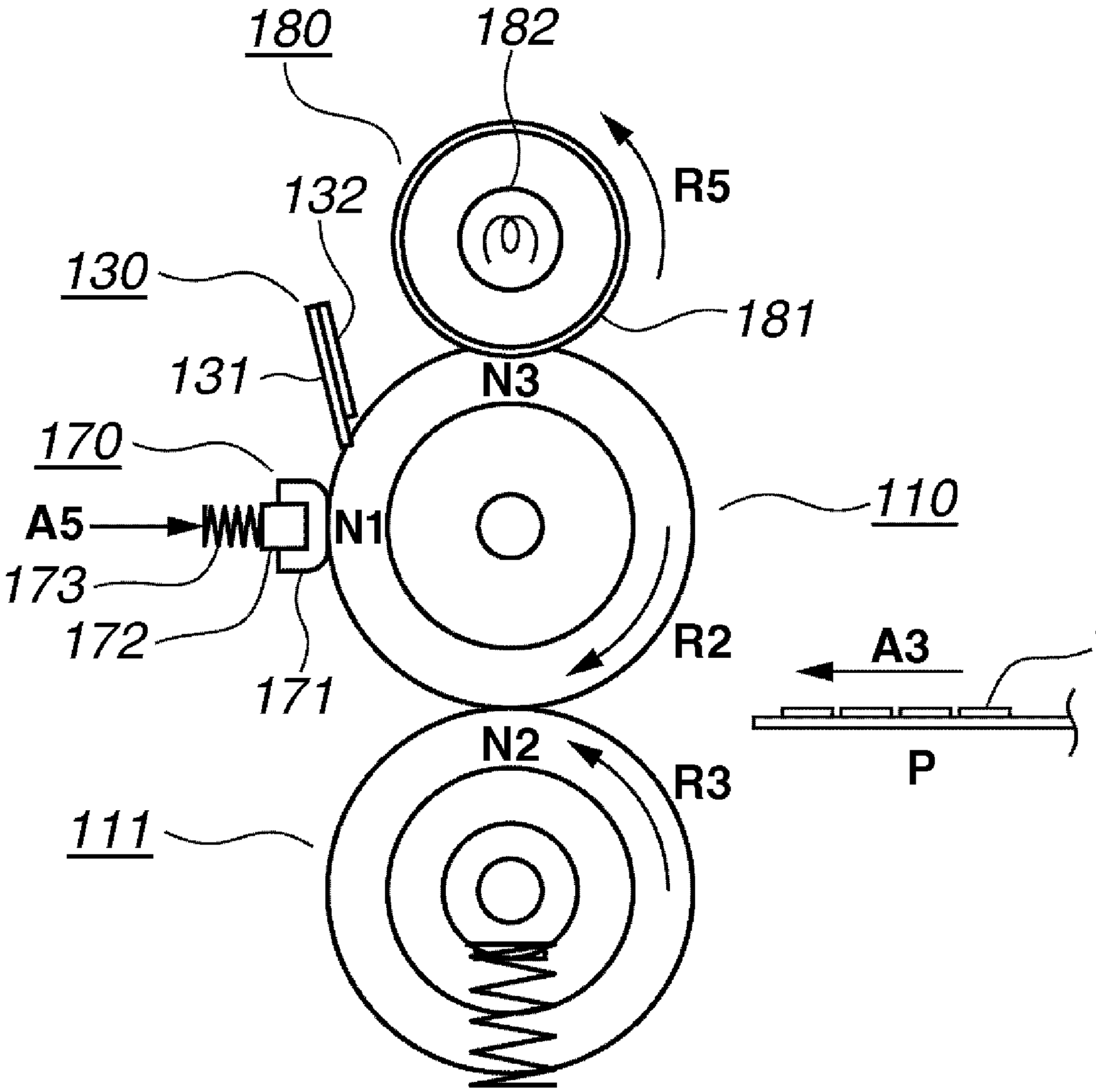


FIG.8


180
182
132
130
R5
181
131
N3
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A5
N1
110
173
172
171
R2
A3
T
N2
R3
P
111

FIG.9

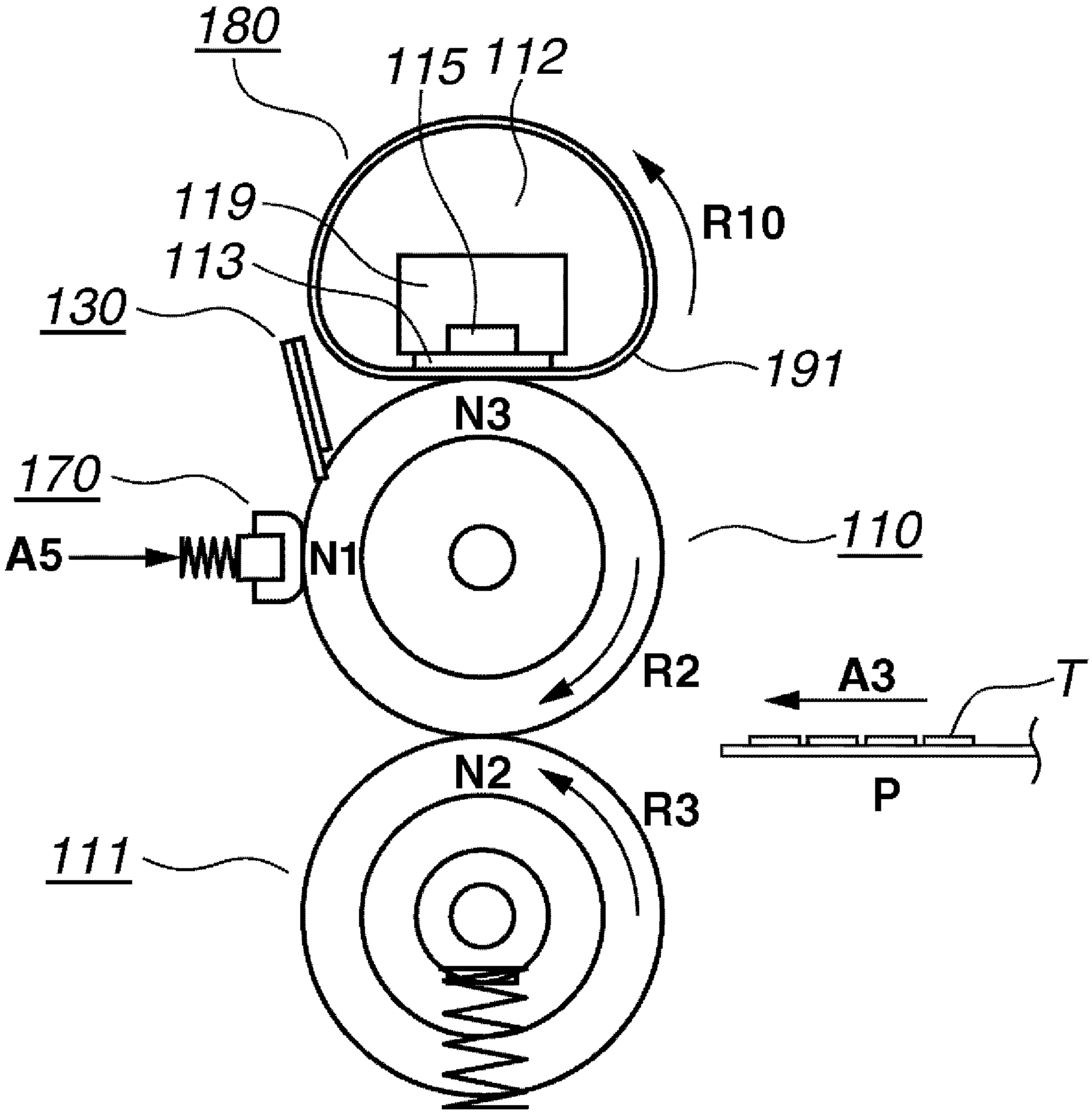

FIG.10

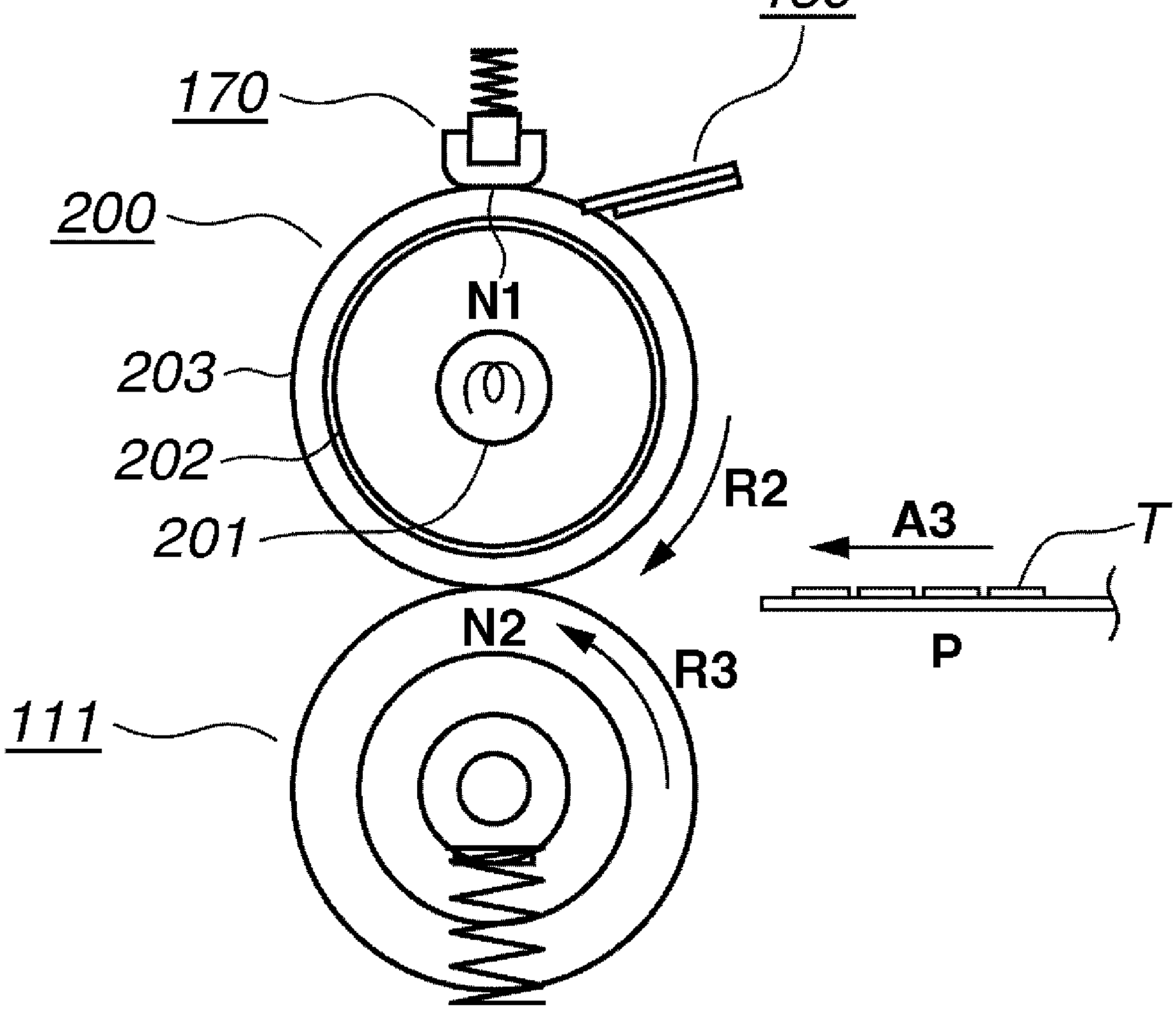

FIG.11

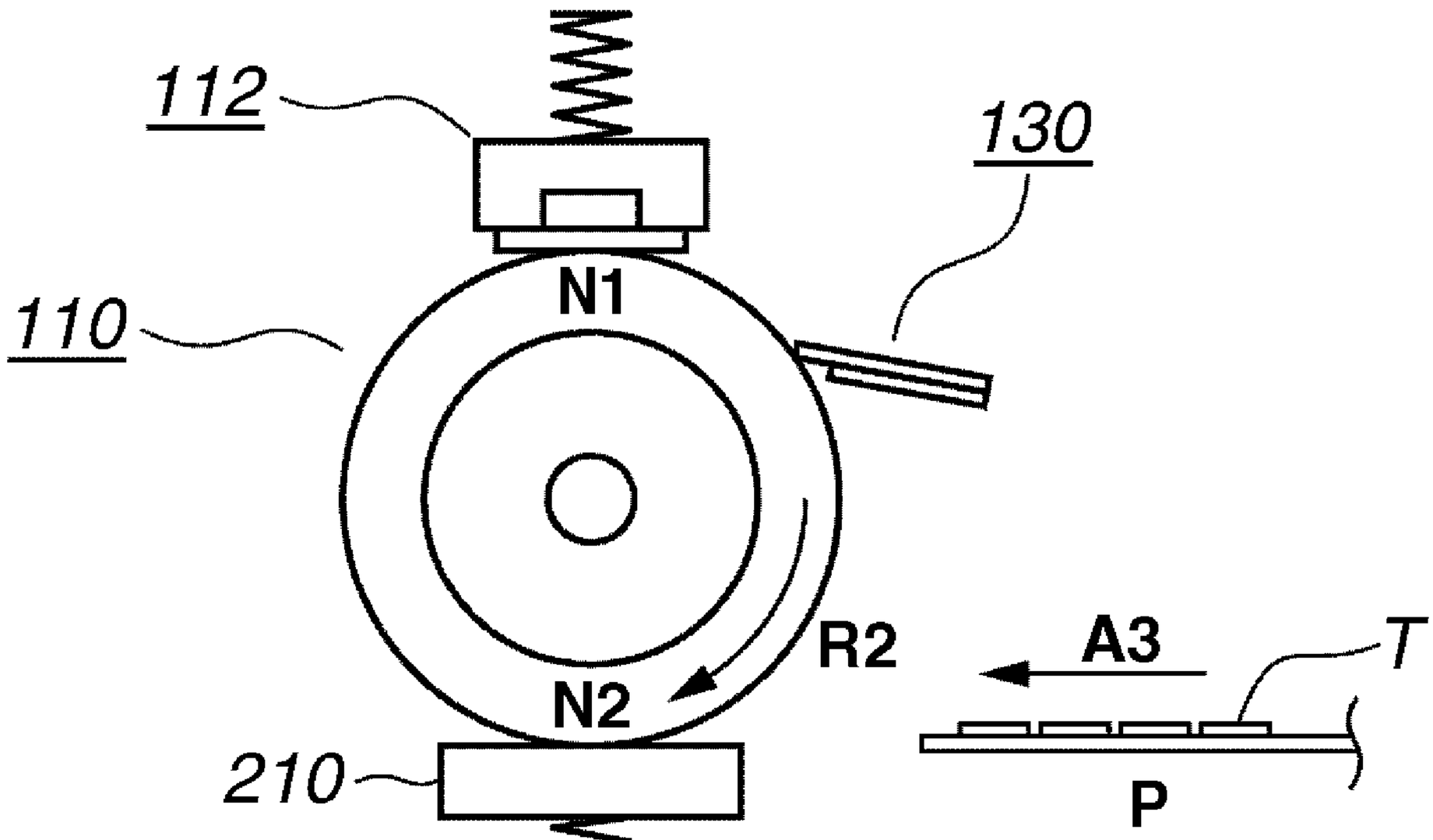

FIG.12

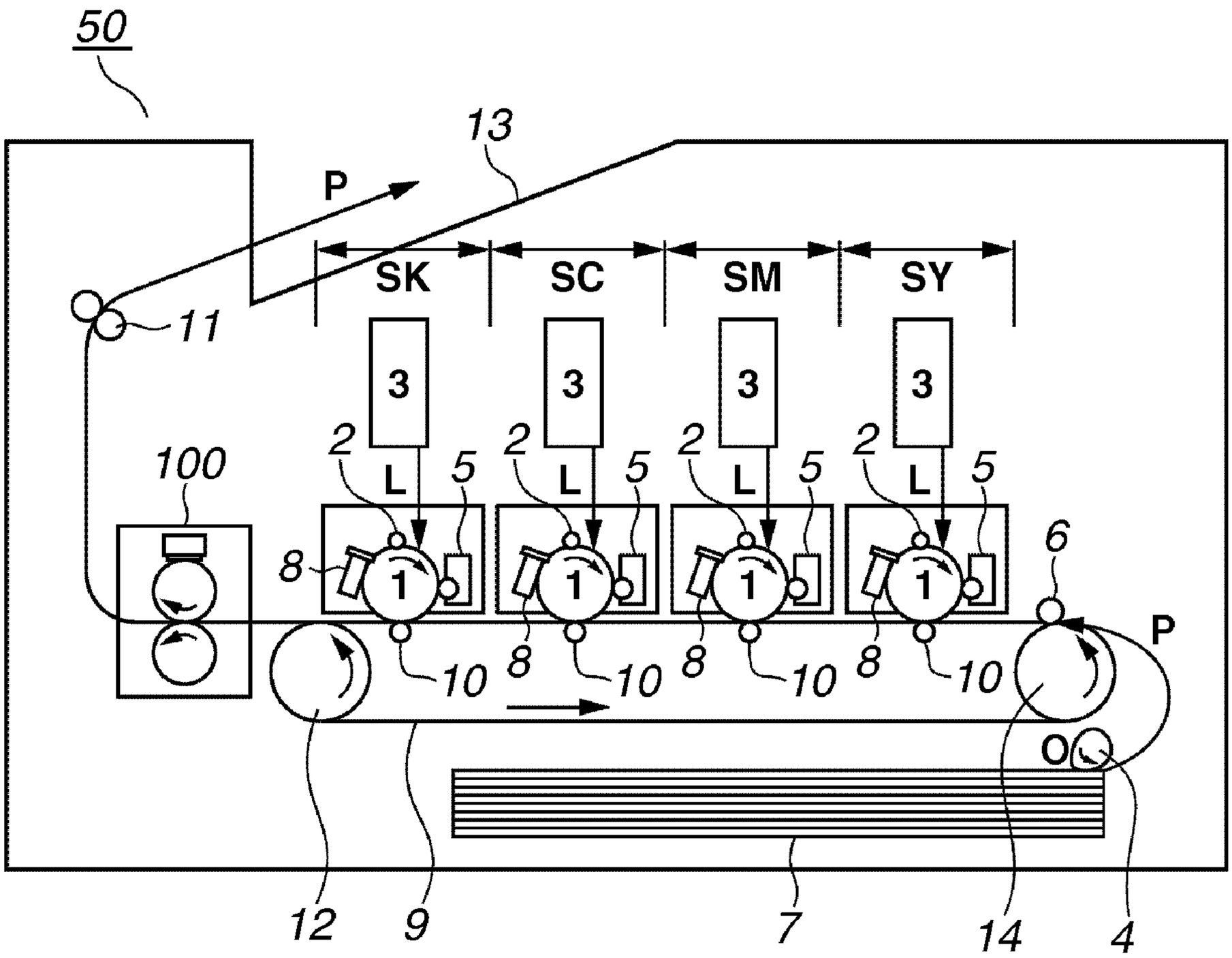

FIG.13

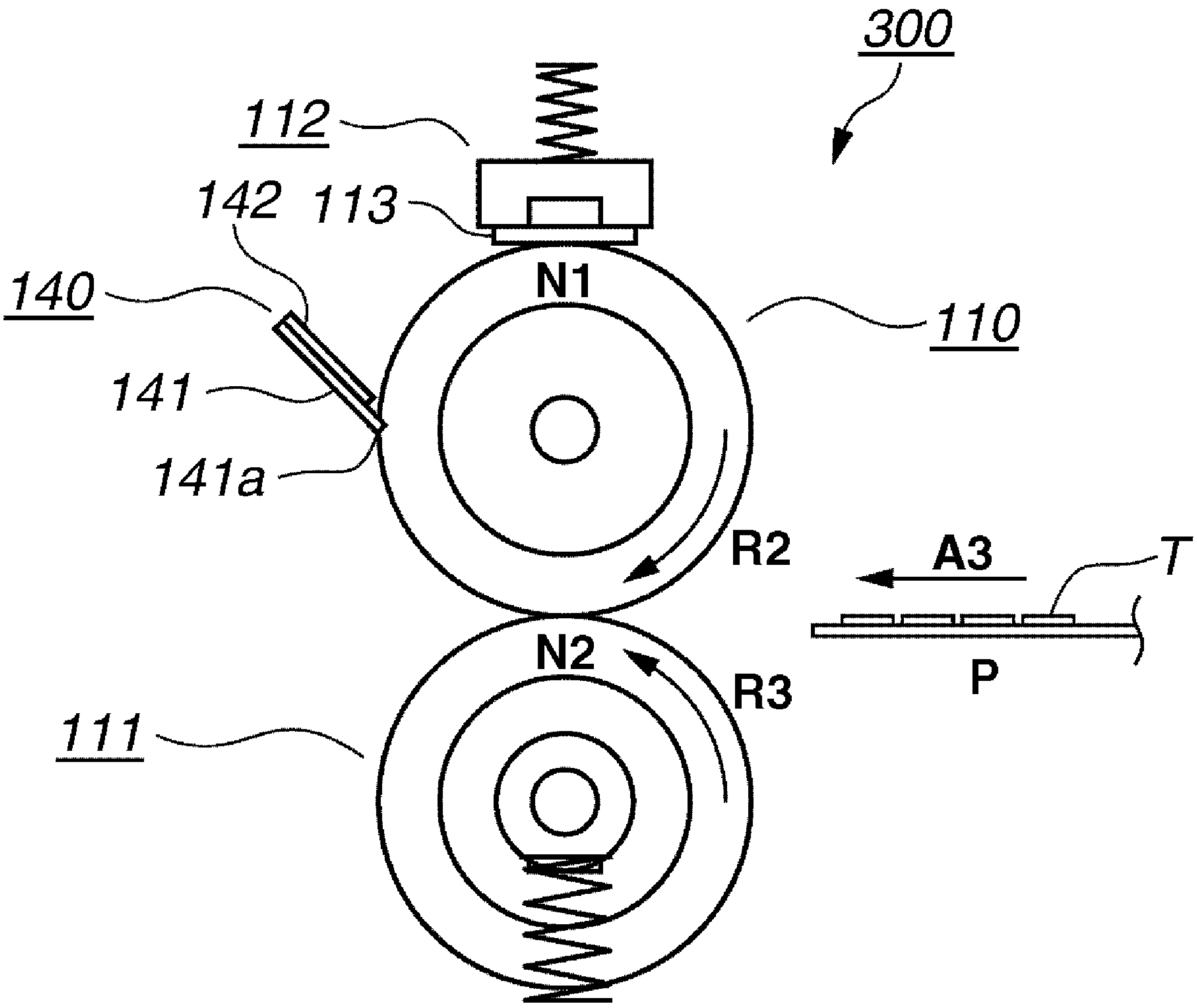

FIG.14

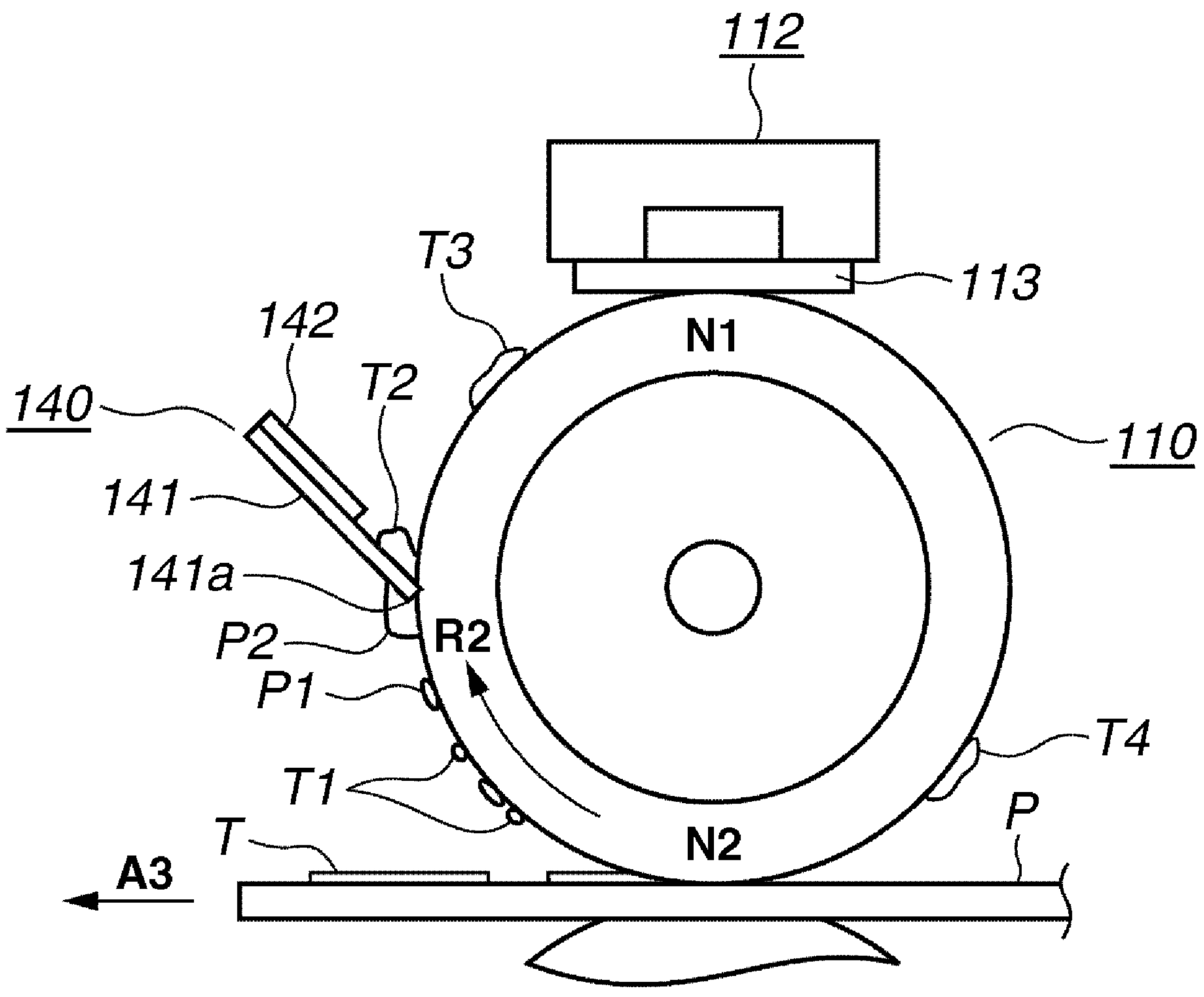

FIG.15

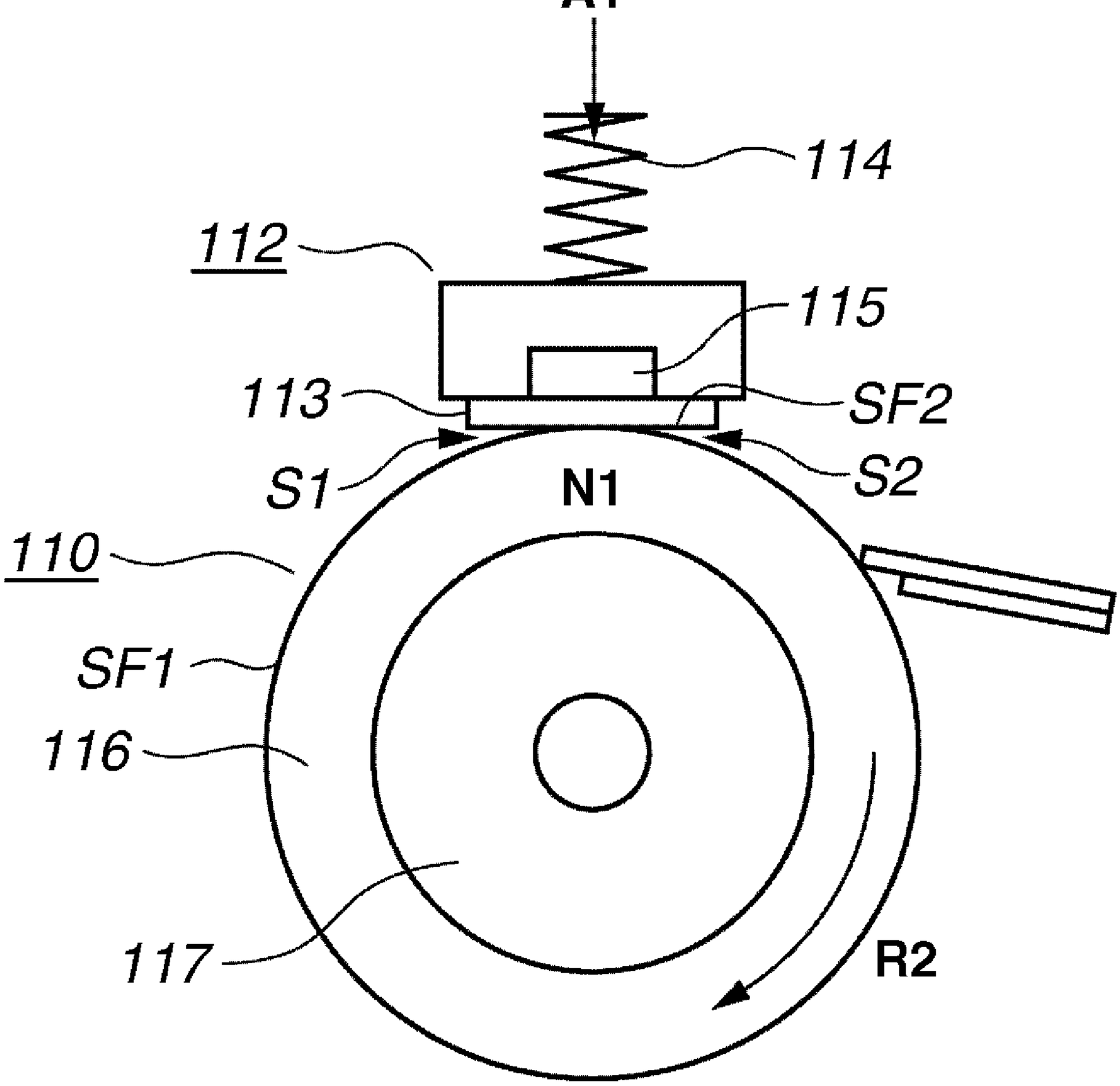

FIG.16

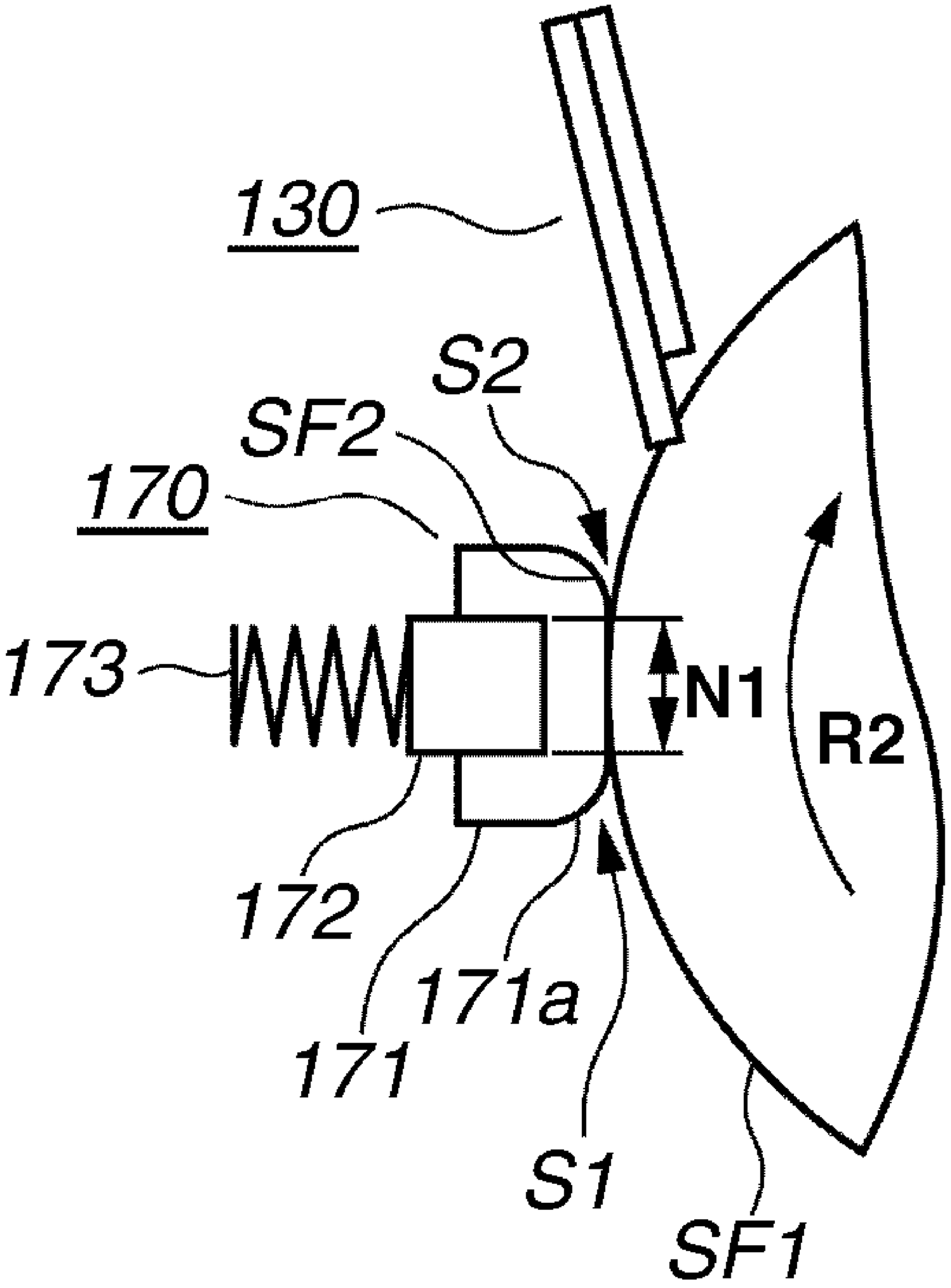

IMAGE HEATING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image heating apparatus that can operate as a heating fixing apparatus (fixing device) installable in an image forming apparatus, such as an electrophotographic copying machine, an electrophotographic printer, or the like.

2. Description of the Related Art

An external heating type fixing apparatus is known as a heating fixing apparatus (fixing device) installable in an electrophotographic copying machine or a printer. The external heating type fixing apparatus includes a heating member (e.g., a heater), a fixing roller heated by the heating member, and a pressing roller contacting the fixing roller to form a nip portion. As discussed in Japanese Patent Application Laid-Open No. 2003-186327, this type of fixing apparatus conveys a recording material carrying an unfixed toner image so that the surface carrying the toner image faces the fixing roller, while the recording material is held at the nip portion and heated by the heating member. Thus, the unfixed toner image on the recording material can be heated and fixed on the recording material.

The external heating type fixing apparatus is roughly classified into a contact-type fixing apparatus that causes the heating member to directly contact an outer circumferential surface of the fixing roller, and a non-contact type fixing apparatus that uses a halogen heater or another non-contact type heating member capable of heating the surface of the fixing roller. When the external heating type fixing apparatus is a contact-type, a heating member (e.g., a ceramic heater) directly contacts the surface of the fixing roller to transfer heat. Therefore, the heat transfer efficiency of the contact-type fixing apparatus is high compared to that of the non-contact type fixing apparatus.

Moreover, the external heating type fixing apparatus of the contact-type is roughly classified into a sliding contact-type fixing apparatus and a movable contact-type fixing apparatus. The sliding contact-type fixing apparatus includes a heating member, which is brought into contact with the surface of a fixing roller and is slidable. The movable contact-type fixing apparatus includes a heating film, which is heated by a heating member and moves together with the surface of a fixing roller, as discussed in Japanese Patent Application Laid-Open No. 2002-236426.

In these fixing apparatuses, when an unfixed toner image on a recording material (e.g., recording paper) is fixed, a small amount of dirt (offset toner, paper dust, etc.) adheres to the outer circumferential surface of a fixing member (e.g., the fixing roller, a fixing film, etc.). If the dirt remains on the surface of the fixing member due to repeated printing, the dirt may be transferred from the fixing member to recording paper and generate a defective image.

Therefore, as discussed in Japanese Patent Application Laid-Open No. 3-65167, a cleaning blade capable of scraping the dirt off the surface of the fixing member can be provided. As discussed in Japanese Patent Application Laid-Open No. 2001-154529, a cleaning weave capable of wiping the dirt off the surface of the fixing member can be provided. The cleaning blade and the cleaning weave can remove the dirt off the surface of the fixing member, and can reduce generation of a defective image.

However, if the above-described conventional fixing apparatus uses the cleaning blade to clean the surface of the fixing member, the cleaning by the cleaning blade may be insufficient and a defective image may be generated. As described above, when the unfixed toner image on a recording paper is fixed, a small amount of dirt (offset toner, paper dust, etc.) adheres to the surface of the fixing member.

The cleaning blade, when it is used to clean the surface of the fixing member, can collect the paper dust or any dirt stable against the heat from the fixing member. However, the toner or another dirt that melts by the heat from the fixing member may pass through the blade. If the fixing apparatus uses a cleaning pad (felt, unwoven fabric, etc.) to clean the surface of the fixing member, the toner melted by the heat from the fixing member may partly pass through the cleaning pad and may be discharged to the surface of the fixing member. The toner discharged on the surface of the fixing member is transferred to a subsequent recording paper conveyed by the fixing nip portion and soils an image on the subsequent recording paper.

On the other hand, when the fixing apparatus uses a cleaning weave to clean the surface of the fixing member, the cleaning weave can periodically change its cleaning surface to prevent the melted toner from passing through the cleaning weave. However, the configuration of the fixing apparatus becomes complicated and the cost of the fixing apparatus increases.

SUMMARY OF THE INVENTION

Exemplary embodiments of the present invention are directed to an image heating apparatus capable of preventing dirt from accumulating on the surface of a rotatable heating member.

According to an aspect of the present invention, an image heating apparatus for heating a toner image formed on a recording medium includes a heating roller configured to contact the toner image on the recording medium to heat the toner image; a heating source configured to heat the heating roller; a back-up member configured to contact a surface of the heating roller to form a heating nip portion together with the heating roller, so that the recording medium is held between the heating roller and the back-up member and conveyed in a predetermined conveyance direction; a contact-sliding member having a length in a direction parallel to a generatrix of the heating roller, which is not smaller than the width of a maximum recording medium that can be processed by the image heating apparatus, and configured to contact the surface of the heating roller, wherein a contact surface of the contact-sliding member contacting the surface of the heating roller is a non-movable surface, wherein an inlet space is formed between the surface of the heating roller and the contact surface of the contact-sliding member on the upstream side of a contact area between the surface of the heating roller and the contact-sliding member in the rotational direction of the heating roller, and an outlet space is formed between the surface of the heating roller and the contact surface of the contact-sliding member on the downstream side of the contact area in the rotational direction; and a cleaning member positioned on the downstream side of the outlet space and on the upstream side of the heating nip portion in the rotational direction and configured to contact the surface of the heating roller.

Further features and aspects of the present invention will become apparent from the following detailed description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate exemplary

embodiments and features of the invention and, together with the description, serve to explain at least some of the principles of the invention.

FIG. **1** is a cross-sectional view illustrating a main portion of a fixing apparatus according to a first exemplary embodiment of the present invention.

FIG. **2** is a front view illustrating the fixing apparatus according to the first exemplary embodiment, although its central portion in the longitudinal direction is partly omitted.

FIG. **3** is an enlarged cross-sectional view illustrating a contact-sliding portion and its vicinity of the fixing apparatus according to the first exemplary embodiment.

FIG. **4** illustrates an example heater.

FIG. **5** illustrates a cleaning blade of the fixing apparatus in the process of cleaning the surface of a fixing roller according to the first exemplary embodiment.

FIG. **6** is a cross-sectional view illustrating a main portion of another fixing apparatus according to the first exemplary embodiment, which uses a cleaning pad as an example cleaning member.

FIG. **7** is a cross-sectional view illustrating a main portion of another fixing apparatus according to the first exemplary embodiment, which uses a brush cleaning roller as an example cleaning member.

FIG. **8** is a cross-sectional view illustrating a main portion of a fixing apparatus according to a second exemplary embodiment of the present invention.

FIG. **9** is a cross-sectional view illustrating a main portion of another fixing apparatus according to the second exemplary embodiment.

FIG. **10** is a cross-sectional view illustrating a main portion of the fixing apparatus according to the second exemplary embodiment.

FIG. **11** is a cross-sectional view illustrating a main portion of a fixing apparatus, which uses a pad member as an example back-up member.

FIG. **12** illustrates an example configuration of an image forming apparatus according to an exemplary embodiment of the present invention.

FIG. **13** is a cross-sectional view illustrating a main portion of a comparative fixing apparatus.

FIG. **14** illustrates a cleaning blade of the comparative fixing apparatus in the process of cleaning the surface of a fixing roller.

FIG. **15** is an enlarged view illustrating the contact-sliding portion and its vicinity illustrated in FIG. **1**.

FIG. **16** is an enlarged view illustrating the contact-sliding portion and its vicinity illustrated in FIG. **8**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The following description of exemplary embodiments is illustrative in nature and is in no way intended to limit the invention, its application, or uses. Processes, techniques, apparatus, and systems as known by one of ordinary skill in the art are intended to be part of the enabling description where appropriate. It is noted that throughout the specification, similar reference numerals and letters refer to similar items in the following figures, and thus once an item is described in one figure, it may not be discussed for following figures. Exemplary embodiments will be described in detail below with reference to the drawings.

FIG. **12** illustrates an example configuration of an image forming apparatus, which can incorporate an image heating apparatus according to an exemplary embodiment of the present invention, as a heating fixing apparatus (fixing device). The image forming apparatus is an electrophotographic full-color laser printer.

The image forming apparatus **50** according to the present exemplary embodiment includes first to fourth image forming stations SY, SM, SC, and SK, which can form yellow (Y), magenta (M), cyan (C), and black (K) toner images. Each of the image forming stations SY, SM, SC, and SK includes a drum type electrophotographic photosensitive member (hereinafter, referred to as "photosensitive drum") **1**, which can operate as an image carrier. A charging device **2** operable as a charging unit, an exposure apparatus **3** operable as an exposure unit, a developing device **5** operable as a developing unit, a drum cleaner **8** operable as a cleaning unit are disposed around the photosensitive drum **1** along the rotational direction of the photosensitive drum **1**.

An endless recording material conveyance belt **9** operable as a recording material conveyance unit is provided in a confronting relationship with the outer circumferential surface of the photosensitive drum **1** of respective image forming stations SY, SM, SC, and SK. The recording material conveyance belt **9** is stretched around two roller shafts (i.e., a driving roller **12** and a tension roller **14**). The recording material conveyance belt **9** is made of a dielectric resin material, which can hold a recording material P with an electrostatic force. A transfer roller **10** operable as a transfer unit is disposed in a confronting relationship, via the recording material conveyance belt **9**, with the photosensitive drum **1** of respective image forming stations SY, SM, SC, and SK. Thus, a contact portion between the photosensitive drum **1** and the recording material conveyance belt **9** can serve as a transfer portion.

The image forming apparatus according to the present exemplary embodiment executes a predetermined image formation sequence in response to a print signal supplied from a host computer or another external apparatus (not illustrated), and performs an image forming operation according to the image formation sequence. Each photosensitive drum **1** rotates in an arrow direction at a predetermined circumferential speed (process speed). The recording material conveyance belt **9** is driven by the driving roller **12** and travels in an arrow direction at a traveling speed corresponding to the circumferential speed of the photosensitive drum **1**.

First, at the yellow (first color) image forming station SY, the charging device **2** uniformly charges the surface of the photosensitive drum **1** to have a predetermined polarity and a predetermined electric potential. In the present exemplary embodiment, the surface of the photosensitive drum **1** has a negative polarity. Next, the exposure apparatus **3** scans and exposes a charging surface of the photosensitive drum **1** to a laser beam L emitted based on image information supplied from the external apparatus. Thus, an electrostatic latent image according to the image information is formed on the charging surface of the photosensitive drum **1**. The developing device **5** develops the electrostatic latent image with the yellow toner (developer). A toner image (developed image) is thus formed on the surface of the photosensitive drum **1**.

Similarly, the above-described charging, exposure, and development processes are performed at the magenta (second color) image forming station SM, the cyan (third color) image forming station SC, and the black (fourth color) image forming station SK. As a result, toner images (developed images) of respective colors are formed on the surfaces of the photosensitive drums **1** of the image forming stations SY, SM, SC, and SK.

A paper feeding roller **4** feeds the recording material P from a paper feeding cassette **7**, which has a storage capacity of a predetermined number of recording sheets. A positive bias is applied to an attraction roller **6**, which charges the

recording material P. The charged recording material P is electrostatically attracted and held on the outer circumferential surface of the recording material conveyance belt **9**. The recording material P is successively conveyed from the transfer portion positioned on the upstream side of the recording material conveyance belt **9** to the transfer portion positioned on the downstream side of the recording material conveyance belt **9**, while the recording material conveyance belt **9** travels at the predetermined speed corresponding to the process speed of the photosensitive drum **1**.

A transfer bias having a predetermined polarity, which is opposite to that of the toner image, is applied to the transfer roller **10** of each of the image forming stations SY, SM, SC, and SK in the process of conveying the recording material P. The transfer bias applied on each transfer roller **10** causes the toner images on the corresponding surfaces of the photosensitive drums **1** of respective image forming stations SY, SM, SC, and SK to successively transfer to the surface of the recording material P. Thus, the recording material P can carry an unfixed full-color toner image on its surface, which results when all of the toner images are successively overlaid on the recording material P.

The recording material conveyance belt **9** conveys the recording material P carrying the unfixed full-color toner image to a heating fixing apparatus (fixing device) **100**. When the recording material P passes through a nip portion N**2** of the fixing apparatus **100**, the fixing apparatus **100** thermally fixes the unfixed toner image on the recording material P. Discharge rollers **11** receive the recording material P carrying the toner image fixed thereon and discharge the recording material P to a discharge tray **13**.

The drum cleaner **8** removes toner particles from the surface of the photosensitive drum **1** and recovers the removed toner particles, when the toner particles remain on the surface of the photosensitive drum **1** without being used for formation of the toner image.

In the following description for the fixing apparatus and its constituent member, the longitudinal direction is the direction perpendicular to a conveyance direction of the recording material and the widthwise direction is the direction parallel to the conveyance direction of the recording material. The length is defined as a size in the longitudinal direction. The width is a size in the widthwise direction.

FIG. **1** is a cross-sectional view illustrating a main portion of the fixing apparatus **100**. FIG. **2** is a front view illustrating the fixing apparatus **100**, although its central portion in the longitudinal direction is partly omitted. The fixing apparatus **100** is an external heating type fixing apparatus. More specifically, the fixing apparatus **100** is a sliding contact-type fixing apparatus including a heating member, which is brought into contact with the surface of a fixing roller and can slide.

The fixing apparatus **100** according to the present exemplary embodiment includes a fixing roller **110** operable as a rotatable heating member, a heater unit **112**, a pressing roller **111** operable as a back-up member, and a cleaning member **130**. The pressing roller **111** has an outer circumferential surface that can form a nip portion (heating nip portion) N**2** when it is brought into contact with an outer circumferential surface of the fixing roller **110**. The heater unit **112** includes a heater **113** serving as a contact-sliding member. The heater **113** contacts the surface of the fixing roller **110** at a position different from the nip portion N**2** in the rotational direction of the fixing roller **110**. The heater **113** forms a contact-sliding portion (contact area) N**1** having a length longer than a contact area of the recording material P having a maximum size that the apparatus can use in the generatrix direction of the fixing roller **110**.

The cleaning member **130** is a member capable of cleaning the surface of the fixing roller **110**. The cleaning member **130** is positioned on the downstream side of the contact-sliding portion N**1** and on the upstream side of the nip portion N**2** in the rotational direction of the fixing roller **110**. Each of the fixing roller **110**, the heater **113**, the pressing roller **111**, and the cleaning member **130** is a thin member extending in the longitudinal direction. The heater **113** serving as the contact-sliding member has a non-movable contact surface that contacts the surface of the fixing roller **110**.

The fixing roller **110** includes an iron cored bar **117** having a diameter of ϕ12 mm and an elastic layer (a foamed rubber layer) **116** provided on the outer circumferential surface of the cored bar **117**. The elastic layer **116** has a thickness of 4 mm and is made of a foamed silicone rubber.

If the fixing roller **110** has large values in heat capacity and heat conductivity, the heat smoothly enters from the outer surface of the fixing roller **110** and is absorbed by the internal member of the fixing roller **110**. The surface temperature does not increase so efficiently. In other words, an insulating member having lower values in heat capacity and heat conductivity can reduce the rise time required to increase the temperature of the surface of the fixing roller **110**.

The heat conductivity of the foamed rubber layer **116** is in the range of 0.11 to 0.16 W/m·K, which is lower than the heat conductivity of a solid rubber (approximately 0.25 to 0.29 W/m·K). The specific gravity of the foamed rubber **116** is approximately 0.75 to 0.85, which is lower than the specific gravity of the solid rubber (approximately 1.05 to 1.30). The specific gravity is relevant to the heat capacity. Therefore, the foamed rubber **116** has a low heat capacity. Accordingly, the foamed rubber **116** can reduce the rise time required to increase the temperature of the surface of the fixing roller **110**. When the fixing roller **110** has a small outer diameter, the fixing roller **110** has a smaller heat capacity. However, if the outer diameter of the fixing roller **110** is excessively small, the width of the contact-sliding portion N**1** becomes narrower. In the present exemplary embodiment, the fixing roller **110** has an outer diameter of ϕ20 mm as an appropriate diameter.

If the thickness of the elastic layer **116** is excessively thin, the heat leaks to the metallic cored bar **117**. In the present exemplary embodiment, the elastic layer **116** has a thickness of 4 mm as an appropriate thickness.

A releasing layer **118**, which is made of a perfluoroalkoxy resin (PFA) and serves as a toner releasing layer, is formed on an outer circumferential surface of the elastic layer **116**. The releasing layer **118** is a coated tube or can be a paint layer coated on the surface of the elastic layer **116**. In the present exemplary embodiment, the releasing layer **118** is made of a tube having an excellent durability. The material usable for the releasing layer **118** is not limited to the PFA and can be selected from fluorine resins, such as a polytetrafluorethylene resin (PTFE), a tetrafluorethylene-hexafluoropropylene resin (FEP), etc., and fluorine rubbers and silicone rubbers having good separation properties.

If the surface hardness of the fixing roller **110** is low, the contact-sliding portion N**1** having a sufficient width can be easily obtained even if the applied pressure is low. However, if the surface hardness of the fixing roller **110** is excessively low, the durability of the fixing roller **110** becomes insufficient. In the present exemplary embodiment, the fixing roller **110** has a surface hardness of 40 to 45° in the Asker-C hardness (at the load of 4.9 N).

The cored bar **117** of the fixing roller **110** has an elongated body extending in the longitudinal direction and supported at both ends thereof by a pair of side plates **151** of an apparatus frame **150** via bearings **152** as to be rotatable. A fixing motor M (a driving unit) drives a driving gear G provided on one end of the cored bar **117** in the longitudinal direction. As a result, the fixing roller **110** rotates in the direction indicated by an arrow R**2** with a surficial moving speed of 60 mm/sec.

To suppress heat transfer from the fixing roller **110** to the pressing roller **111**, it is desired that the material for the pressing roller **111** has lower values in both heat capacity and heat conductivity. In the present exemplary embodiment, the pressing roller **111** is made of a material similar to that of the fixing roller **110**.

The pressing roller **111** has an outer diameter of ϕ20 mm. The pressing roller **111** includes an iron cored bar **121** having a diameter of ϕ12 mm and an elastic layer **122** provided on the outer circumferential surface of the cored bar **121**. The elastic layer **122** is a foamed rubber layer having a thickness of 4 mm. A releasing layer **123** (e.g., a PFA-made layer), serving as an outermost layer, is provided on the outer circumferential surface of the elastic layer **122**.

The pressing roller **111** is positioned below the fixing roller **110** and is disposed in parallel with the fixing roller **110**. The cored bar **121** has an elongated body extending in the longitudinal direction and supported at both ends thereof by the side plates **151** of the apparatus frame **150** via the bearings **125** to as to be rotatable. A pair of pressing springs **124**, pressing the bearings **125** in an upward direction A**2**, applies a predetermined pressing force to the pressing roller **111**. Thus, the surface of the pressing roller **111** contacts the surface of the fixing roller **110**.

The pressing force of the pressing springs **124** causes the elastic layer **122** of the pressing roller **111** and the elastic layer **116** of the fixing roller **110** to elastically deform to form a nip portion (a fixing nip portion (a heating nip portion)) N**2** having a predetermined width between the surface of the pressing roller **111** and the surface of the fixing roller **110**. In the present exemplary embodiment, the pressing force applied from the pressing springs **124** to the bearings **125** is 147 N and the nip portion N**2** having a width of 7 mm is formed.

FIG. **3** is an enlarged cross-sectional view illustrating the contact-sliding portion N**1** and its vicinity of the fixing apparatus **100**. FIG. **4** illustrates an example heater.

In the heater unit **112**, the heater **113** is held by a heater holder **119**. The heater holder **119** has an elongated body extending in the longitudinal direction and held at both ends thereof by the pair of side plates **151**. A pair of pressing springs **114**, generating the pressing force acting in a downward direction A**1**, presses the longitudinal ends of the heater holder **119** to bring the lower surface of the heater **113** into contact with the surface of the fixing roller **110**. The pressing force of the pressing spring **114** elastically deforms the elastic layer **116** of the fixing roller **110**. As a result, the contact-sliding portion N**1** having a predetermined width is formed between the surface of the heater **113** and the surface of the fixing roller **110**. In the present exemplary embodiment, the pressing force applied from the pressing spring **114** to the longitudinal ends of the heater holder **119** is set to 98 N. The contact-sliding portion (contact area) N**1** having a width of 5.5 mm is formed.

FIG. **15** is an enlarged view of the fixing roller **110** and the heater unit **112** illustrated in FIG. **1**. As illustrated in FIG. **15**, an inlet space S**1** is formed between a fixing roller surface SF**1** and a contact surface SF**2** of the heater **113** on the upstream side of the contact area N**1** between the fixing roller surface SF**1** and the heater (contact-sliding member) **113** in the rotational direction of the fixing roller **110**. An outlet space S**2** is formed between the fixing roller surface SF**1** and the contact surface SF**2** of the heater **113** on the downstream side of the contact area N**1** in the rotational direction of the fixing roller **110**.

The heater **113** includes an alumina substrate **113***a* having a width of 6 mm and a thickness of 1 mm. A silver palladium (Ag/Pd) electric heat-generating layer **113***b*, having a thickness of 10 μm, is coated on a surface of the substrate **113***a*, which faces the surface of the fixing roller **110**, along the longitudinal direction of the substrate **113***a*, by screen printing. The electric heat-generating layer (hereinafter, referred to as "heat-generating layer") **113***b* is covered with a glass layer to have a thickness of 50 μm, which serves as a heater protecting layer **113***c* formed on the heat-generating layer **113***b*. In the present exemplary embodiment, to efficiently transfer heat from the heater **113** to the fixing roller **110**, the heater protecting layer **113***c* of the heater **113** is directly brought into contact with the surface of the fixing roller **110** to heat the surface of the fixing roller **110**.

To reduce the frictional force acting between the surface of the heater **113** (the surface of the heater protecting layer **113***c*) and the surface of the fixing roller **110** at the contact-sliding portion N**1**, it is desired to provide a sliding layer (not illustrated) on the surface of the heater protecting layer **113***c* of the heater **113**. A fluorine resin excellent in sliding properties, such as PTFE or PFA, can be used as a material for the sliding layer. If the provided sliding layer is excessively thick, the heat from the heater **113** cannot be smoothly transferred to the fixing roller **110**. If the sliding layer is excessively thin, the sliding layer cannot possess a satisfactory durability. It is, therefore, desired that the thickness of the sliding layer be in the range of 1 to 100 μm. To reduce the contact heat resistance between the sliding layer and the heater **113**, a fluorine resin layer can be directly coated on the heater **113**. Alternatively, the sliding layer can be a sheet-like member excellent in both durability and surface properties.

A temperature detection element **115** is disposed on a back surface of the substrate **113***a* in an opposed relationship with the heater holder **119**. The temperature detection element **115** can detect the temperature of the heater **113**, which rises according to the heat generated by the heat-generating layer **113***b*. In response to an output signal from the temperature detection element **115**, a temperature control unit C appropriately controls the current flowing through the power supply electrodes **113***d* to the heat-generating layer **113***b*. The power supply electrodes **113***d* are continuous from the heat-generating layer **113***b* and provided on the inner side of the substrate **113***a* at both ends thereof in the longitudinal direction. Thus, the temperature control unit C can adjust the temperature of the heater **113** to a predetermined fixing temperature (target temperature).

A drive control unit (not illustrated) drives the fixing motor M, which rotates the driving gear G, according to the print signal. Therefore, the fixing roller **110** rotates in the direction indicated by the arrow R**2** at a surficial moving speed of 60 mm/sec. In this case, the rotational force acts on the pressing roller **111** due to the frictional force at the nip portion N**2** between the surface of the fixing roller **110** and the surface of the pressing roller **111**. The pressing roller **111** rotates in a direction opposite the rotational direction of the fixing roller **110**. Thus, the pressing roller **111** is driven to rotate in the direction indicated by an arrow R**3** at a surficial moving speed similar to that of the fixing roller **110** (see FIG. **1**).

The temperature control unit C adjusts the current flowing through the power supply electrodes **113***d* of the heater **113** according to the print signal. The heat-generating layer **113***b*

generates heat according to the current supplied. The heater **113** can speedily increase the temperature to heat the surface of the fixing roller **110**. The heat-generating layer **113***b* has a length K (see FIG. **4**) along the generatrix of the fixing roller **110**, which is slightly longer than the maximum sheet-passing width J (FIG. **2**) of the maximum recording material P that can be processed by the apparatus.

The temperature detection element **115** detects the temperature of the heater **113** and outputs a detection signal. The temperature control unit C receives the detection signal from the temperature detection element **115** and controls the current flowing through the power supply electrodes **113***d* based on the received detection signal so that the temperature of the heater **113** can be maintained at the predetermined fixing temperature. Therefore, the temperature of the heater **113** is maintained at the predetermined fixing temperature. The heater **113** heats the surface of the fixing roller **110** via the contact-sliding portion N**1**.

In a state where the fixing roller **110** and the pressing roller **111** are stably rotating and the temperature of the heater **113** is maintained at the predetermined fixing temperature, a recording material carrying an unfixed color toner image (hereinafter, referred to as "unfixed toner image") T reaches the nip portion N**2** along a conveyance direction A**3**. The recording material P is held at the nip portion N**2** between the surface of the fixing roller **110** and the surface of the pressing roller **111** and is conveyed in the conveyance direction A**3**. In the conveyance process, the recording material P receives the heat from the surface of the fixing roller **110**, which is heated by the heater **113**, and receives the pressure at the nip portion N**2**. In this manner, the thermal fixation of the toner image T on the recording material P can be realized under the provision of the heat and the pressure.

The cleaning member **130** includes a cleaning blade **131** and a blade holding metal plate **132** holding the cleaning blade **131**.

The cleaning blade **131** has a blade tip portion **131***a* brought into contact with the surface of the fixing roller **110** in a counter fashion, as seen from the rotational direction R**2** of the fixing roller **110**, to efficiently scrape the dirt off the surface of the fixing roller **110**. In the present exemplary embodiment, it is desired that the cleaning blade **131** of the cleaning member **130** be made of a soft resin material rather than a hard metallic member, because the soft resin material does not damage the surface of the fixing roller **110**. It is further desired that the cleaning blade **131** have excellent heat-resisting properties against the heat from the surface of the fixing roller **110**.

In the present exemplary embodiment, the cleaning blade **131** is made of a polyimide resin material excellent in both heat-resisting properties and strength. The polyimide resin-made cleaning blade **131** is disposed on the blade holding metal plate **132** made of a SUS material. The length of the cleaning blade **131** is substantially equal to or longer than the length of the fixing roller **110**. If the thickness of the blade tip portion **131***a* of the cleaning blade **131** is thin, the blade tip portion **131***a* can easily scrape the dirt. However, if the thickness of the blade tip portion **131***a* is excessively thin, the strength of the tip portion **131***a* becomes insufficient. Therefore, it is desired that the thickness of the blade tip portion **131***a* be in the range of 20 μm to 200 μm. In the present exemplary embodiment, the thickness of the blade tip portion **131***a* is set to 100 μm.

A contact angle θ of the blade tip portion **131***a* represents an angle between the blade tip portion **131***a* and a tangential line of the fixing roller **110** at the portion where the blade tip portion **131***a* contacts the surface of the fixing roller **110** (an angle on the downstream side of the contact point of the blade tip portion **131***a* in the rotational direction R**2** of the fixing roller **110**). As the blade tip portion **131***a* contacts the surface of the fixing roller **110** at its front edge, the contact angle of the blade tip portion **131***a* is in the range of 0° to 180° that theoretically enables the cleaning blade **131** to scrape the dirt off the surface of the fixing roller **110**. However, to effectively scrape the dirt, it is desired that the contact angle be in the range of 0° to 90° so that the cleaning blade **131** is bought into contact with the surface of the fixing roller **110** in the counter fashion, as seen from the rotational direction R**2** of the fixing roller **110**. In the present exemplary embodiment, the contact angle of the blade tip portion **131** is set to 40°.

When the blade tip portion **131***a* contacts the surface of the fixing roller **110** at the above-described contact angle (40°), the cleaning blade **131** can efficiently scrape the dirt off the surface of the fixing roller **110**. Additionally, when a contact pressure of the blade tip portion **131***a* is high, the cleaning blade **131** can efficiently scrape the dirt off the surface of the fixing roller **110**. However, if the contact pressure of the blade tip portion **131***a* is excessively high, the blade tip portion **131***a* may damage or abrade the surface of the fixing roller **110**. Therefore, it is desired that the contact pressure (linear pressure) of the blade tip portion **131***a* be in the range of 10 to 500 mN/cm. In the present exemplary embodiment, the contact pressure of the blade tip portion **131***a* is set to 49 mN/cm.

An example process of cleaning the surface of the fixing roller **110**, which can be performed by the fixing apparatus **100** according to the present exemplary embodiment, is described below with reference to FIG. **5**. FIG. **5** illustrates the cleaning blade **131** of the fixing apparatus **100** in the process of cleaning the surface of the fixing roller **110** according to the present exemplary embodiment.

When a recording material (e.g., recording paper) P carrying an unfixed toner image T passes through the nip portion N**2**, a small amount of dirt (e.g., offset toner T**1** and paper dust P**1**) adheres to the surface of the fixing roller **110**. The offset toner T**1** and the paper dust P**1** on the surface of the fixing roller **110** reach the contact-sliding portion N**1** (see T**2** and P**2** in FIG. **5**) because the fixing roller **110** rotates in the direction indicated by the arrow R**2**. The heater **113** forming the contact-sliding portion N**1** has the contact surface SF**2** that contacts the surface SF**1** of the fixing roller **110**. Therefore, the inlet space S**1** (a portion in an opened state) is positioned on the upstream side of the contact-sliding portion N**1** in the rotational direction R**2** of the fixing roller **110**. Therefore, compared to the arrangement using the blade having a front edge contacting the fixing roller, it is difficult to surely remove the paper dust P**2** at the inlet side of the contact-sliding portion N**1**. The offset toner T**2** and the paper dust P**2** having reached the contact-sliding portion N**1** gradually enter the contact-sliding portion N**1**. The offset toner T**2** and the paper dust P**2**, having entered the contact-sliding portion N**1**, receive the heat from the heater **113** and are mixed together.

The offset toner T**2**, which melts at least partly by the heat from the heater **113**, permeates the paper dust P**2**, while it passes through the contact-sliding portion N**1**. The dirt of the paper dust P**2** containing the melted offset toner T**2** basically adheres to the surface SF**2** of the heater **113**. However, due to a significant amount of force acting from the surface SF**1** of the fixing roller **110** moving in the rotational direction R**2**, the dirt on the surface SF**2** of the heater **113** gradually moves to the downstream side of the contact-sliding portion N**1** in the rotational direction R**2** of the fixing roller **110**.

The dirt of the paper dust P**2** containing the melted offset toner T**2**, after passing through the contact-sliding portion N**1**, accumulates in the outlet space S**2** positioned on the

downstream side of the contact-sliding portion N1 (see TP1 illustrated in FIG. **5**). When the number of printed sheets increases, the amount of the paper dust dirt TP1 remaining in the outlet space S2 increases and the size of the paper dust dirt TP1 increases correspondingly. If the contact area of the paper dust dirt TP1 having grown and the surface SF1 of the fixing roller **110** exceeds a predetermined value, the paper dust dirt TP1 may be transferred to the surface of the fixing roller **110** (see TP2 in FIG. **5**).

However, the fixing apparatus **100** according to the present exemplary embodiment includes the cleaning blade **130** provided on the downstream side of the contact-sliding portion N1 and on the upstream side of the nip portion N2 in the rotational direction of the fixing roller **110** (the direction indicated by the arrow R2). Therefore, the blade tip portion **131***a* of the cleaning blade **130** scrapes and removes the paper dust dirt TP2 from the surface of the fixing roller **110** in the intermediate region between the contact-sliding portion N1 and the nip portion N2 (see TP3 in FIG. **5**). The paper dust dirt TP3 having been removed by the blade tip portion **131***a* is collected by a collecting container (not illustrated) provided on the rear end side of the cleaning blade **130**.

The offset toner T2 permeates the paper dust P2 in the process of passing through the contact-sliding portion N1 and becomes part of the paper dust dirt TP2. Therefore, compared to the offset toner T2, the paper dust dirt TP2 has an extremely lower viscosity. In other words, compared to the removal of the offset toner T2, the cleaning blade **131** can easily remove the paper dust dirt TP2. The paper dust dirt TP2 to be scraped by the cleaning blade **130** becomes larger in volume in the process of accumulating (growing) in the outlet space S2. The paper dust dirt TP2 has a sufficiently large body size for the cleaning blade **130** to scrape, compared to the size of the offset toner T2 or the paper dust P2 before reaching the contact-sliding portion N1. The paper dust dirt TP3 having reached the cleaning blade **130** has a sufficiently large body that cannot easily pass through the blade tip portion **131***a*.

As the paper dust dirt TP3 has a small viscosity, the paper dust dirt TP3 can quickly move from the blade tip position to the collecting container after the paper dust dirt TP3 is removed by the blade tip portion **131***a*. Accordingly, after the paper dust dirt TP3 is collected in the collecting container by the cleaning blade **131**, the paper dust dirt TP3 does not melt even when the blade tip portion **131***a* receives the heat from the surface of the fixing roller **110**.

Therefore, the cleaning blade **131** can completely remove the dirt from the surface of the fixing roller **110**. As a result, the recording material P is not soiled. As described above, the present exemplary embodiment causes the paper dust P2 and the toner T2 to grow into a large lump in the inlet space S1 provided on the upstream side of the contact area N1 and the outlet space S2 provided on the downstream side of the contact area N1. Therefore, the present exemplary embodiment can remove the lump of the dirt from the fixing roller surface after the dirt lump has sufficiently grown.

FIG. **13** is a cross-sectional view illustrating a main portion of a comparative fixing apparatus **300**. The comparative fixing apparatus **300** is similar to the fixing apparatus **100** according to the present exemplary embodiment in configuration except that the cleaning member **130** is disposed at a different position. The comparative fixing apparatus **300** includes constituent members similar to those of the fixing apparatus **100** according to the present exemplary embodiment, which are, therefore, denoted using the same reference numerals.

The comparative fixing apparatus **300** includes a cleaning member **140** capable of cleaning the surface of the fixing roller **110**, which is similar to the cleaning member **130** according to the present exemplary embodiment. The cleaning member **140** includes a cleaning blade **141** and a blade holding metal plate **142** holding the cleaning blade **141**. The cleaning blade **141** is positioned on the upstream side of the contact-sliding portion N1 and on the downstream side of the nip portion N2 in the rotational direction R2 of the fixing roller **110**. The cleaning blade **141** includes a blade tip portion **141***a* configured to contact the surface of the fixing roller **110** in a counter fashion in the rotational direction R2 of the fixing roller **110**, to scrape the dirt off the surface of the fixing roller **110**.

An example process of cleaning the surface of the fixing roller **110** of the comparative fixing apparatus **300** is described below with reference to FIG. **14**. FIG. **14** illustrates the cleaning blade **141** of the comparative fixing apparatus **300** in the process of cleaning the surface of a fixing roller **110**.

When a recording material (e.g., recording paper) P carrying an unfixed toner image T passes through the nip portion N2, a small amount of dirt (offset toner T1 and paper dust P1) adheres to the surface of the fixing roller **110**. According to the structure illustrated in FIG. **14**, the blade tip portion **141***a* of the cleaning blade **141** contacts the surface of the fixing roller **110** at its front edge. Therefore, there is no inlet space in the vicinity of the cleaning blade **141**. The blade tip portion **141***a* of the cleaning blade **141** scrapes and removes the offset toner T1 and the paper dust P1 off the surface of the fixing roller **110**.

In this case, the paper dust P1 does not melt by the heat from the surface of the fixing roller **110** and is, therefore, stopped by the blade tip portion **141***a*. As a result, a lump of the paper dust P1 is accumulated on the front surface of the cleaning blade **141** (see P2 in FIG. **14**). On the other hand, the offset toner T1 melts by the heat from the surface of the fixing roller **110** and, therefore, can pass through the blade tip portion **141***a*. As a result, a lump of the offset toner T1 is accumulated on the back surface of the blade tip portion **141***a* (see T2 in FIG. **14**).

If the accumulation amount of the offset toner T2 on the back surface of the blade tip portion **141***a* increases due to repeated printing, and if the contact area between the offset toner T2 and the surface of the fixing roller **110** is sufficiently large, the offset toner T2 may be discharged to the surface of the fixing roller **110** (see T3 in FIG. **14**). The offset toner T3 discharged to the surface of the fixing roller **110** is in a melting state and, therefore, passes through the contact-sliding portion N1 (see T4 in FIG. **14**) and may soil the surface of the recording material P.

A print durability test was conducted and its result was compared between the fixing apparatus **100** according to the present exemplary embodiment and the comparative fixing apparatus **300**. The print durability test includes continuously printing an image having a printing rate of 5% and confirming the presence of any dirt on each recording paper by visual check.

In the comparative fixing apparatus **300**, the offset toner adhering on the surface of the fixing roller **110** melts by the heat from the fixing roller **110**. As a result, the offset toner passes through the blade tip portion **141***a* and the contact-sliding portion N1. Therefore, at the time when the number of printed sheets has reached 1,000, a very small amount of dirt was first confirmed on recording paper. After that, a similar dirt was confirmed once every 100 recording sheets. Further, at the time when the number of printed sheets exceeds 50,000, a relatively expanded dirt was confirmed on recording paper.

After that, a similar dirt was confirmed at two or more portions on recording paper once every 20 recording sheets.

On the other hand, in the fixing apparatus **100** according to the present exemplary embodiment, the contact-sliding portion N**1** can adequately mix the offset toner with the paper dust adhering on the surface of the fixing roller **110** and let the mixed dirt grow into a larger lump in the outlet space. The cleaning blade **131** collects the enlarged lump of the dirt. Therefore, the present exemplary embodiment can prevent the dirt from being discharged (returned) from the cleaning blade **131** to the surface of the fixing roller **110**. Thus, in the fixing apparatus **100** according to the present exemplary embodiment, no dirt was confirmed on each recording sheet until the number of printed sheets reaches 100,000 corresponding to the endurance life of the fixing apparatus **100**.

In the comparative fixing apparatus **300**, the offset toner dirt melting by the heat from the fixing roller **110** easily passes through the cleaning blade **141**. Alternatively, in the case where the comparative fixing apparatus **300** does not include the contact-sliding member that contacts and slides along the surface of the fixing roller **110**, the offset toner dirt melting by the heat from the fixing roller passes through the cleaning blade **141**.

In the fixing apparatus **100** according to the present exemplary embodiment, the cleaning member **130** is not limited to the cleaning blade **131** and can be any member capable of removing the dirt off the surface of the fixing roller **110**.

FIG. **6** is a cross-sectional view illustrating a main portion of the fixing apparatus **100**, which uses a cleaning pad **1150** as an example of the cleaning member **130**.

The cleaning pad **1150** includes a pad holding metal plate **1152** made of a SUS material and a nonwoven fabric pad **1151** made of an aramid member having a thickness of 1 mm and wound around the pad holding metal plate **1152**. A pad pressing spring **153** presses the cleaning pad **1150** toward the center of the cored bar **117** of the fixing roller **110** along the direction indicated by an arrow A**4**. The pressing force of the pad pressing spring **153** brings the nonwoven fabric pad **1151** of the cleaning pad **1150** into contact with the surface of the fixing roller **110**.

Compared to the arrangement using the cleaning blade **131** serving as the cleaning member **130**, the fixing apparatus **100** using the cleaning pad **1150** serving as the cleaning member **130** can select a soft material for the cleaning member **130**. Therefore, the fixing apparatus **100** using the cleaning pad **1150** serving as the cleaning member **130** does not damage the surface of the fixing roller **110**. In the fixing apparatus **100**, the contact-sliding portion N**1** can adequately mix the offset toner with the paper dust adhering on the surface of the fixing roller **110** and let the mixed dirt grow into a larger lump in the outlet space. The nonwoven fabric pad **1151** collects the paper dust dirt containing the permeated offset toner from the surface of the fixing roller **110**. Therefore, the present exemplary embodiment prevents the dirt from being discharged (returned) from the cleaning pad **1150** to the surface of the fixing roller **110**.

As illustrated in FIG. **7**, a brush cleaning roller **160** can be used as the cleaning member **130**.

FIG. **7** is a cross-sectional view illustrating a main portion of the fixing apparatus **100**, which uses the brush cleaning roller **160** as an example of the cleaning member **130**.

The cleaning roller **160** is made of a polyimide resin having excellent heat-resisting properties and is configured into a brush roll shape. The cleaning roller **160** rotates in the direction indicated by an arrow R**4** (i.e., the counter direction) against the rotation of the fixing roller **110**, while the brush of the cleaning roller **160** scrapes the dirt off the surface of the fixing roller **110**. A flicker **162**, made of a SUS material, shakes off the dirt scraped by the cleaning roller **160** from the cleaning roller **160**.

The fixing apparatus **100** using the brush cleaning roller **160** serving as the cleaning member **130** can reduce the frictional resistance between the cleaning roller **160** and the fixing roller **110** and, therefore, can reduce the rotational torque of the fixing roller **110**. In the fixing apparatus **100**, the contact-sliding portion N**1** can adequately mix the offset toner with the paper dust adhering on the surface of the fixing roller **110** and let the mixed dirt grow into a larger lump in the outlet space. The cleaning roller **160** collects the paper dust dirt containing the permeated offset toner from the surface of the fixing roller **110**. Therefore, the present exemplary embodiment prevents the dirt from being discharged (returned) from the cleaning roller **160** to the surface of the fixing roller **110**.

The fixing apparatus **100** according to the present exemplary embodiment provides the contact-sliding portion N**1** formed by bringing the heater **113** into contact with the surface of the fixing roller **110** so as to provide the inlet space and the outlet space. The offset toner and the paper dust adhering on the surface of the fixing roller **110** can be adequately mixed with each other and grow into a large lump of the dirt. Therefore, the paper dust dirt can be easily removed from the surface of the fixing roller **110**.

The cleaning member **130** is positioned on the downstream side of the contact-sliding portion N**1** and on the upstream side of the nip portion N**2** in the rotational direction of the fixing roller **110**. The paper dust dirt can be surely removed from the surface of the fixing roller **110** before the paper dust dirt reaches the nip portion N**2**. Accordingly, the fixing apparatus **100** according to the present exemplary embodiment can prevent the dirt from remaining on the surface of the fixing roller **110**, without complicating the structure of the fixing apparatus **100**. The fixing apparatus **100** according to the present exemplary embodiment can prevent a defective image from being generated by the dirt of the surface of the fixing roller **110**.

The fixing apparatus **100** according to the present exemplary embodiment causes the heater **113** to heat the fixing roller **110** via the contact surface thereof. The fixing apparatus **100** can reduce the rise time required to increase the surface temperature of the fixing roller **110** to the predetermined fixing temperature after starting power supply to the heater **113**. Thus, the fixing apparatus **100** can reduce electric power consumption.

In the fixing apparatus **100** according to the present exemplary embodiment, the fixing roller **110** includes the elastic layer **116**. Therefore, the heater **113** and the fixing roller **110** can hermetically contact with each other. The offset toner and the paper dust adhering on the surface of the fixing roller **110** can be effectively mixed at the contact-sliding portion N**1**. Therefore, the cleaning member **130** can surely remove the dirt mixture containing the paper dust and the offset toner off the surface of the fixing roller **110**.

When the fixing apparatus **100** according to the present exemplary embodiment uses the cleaning blade **131** serving as the cleaning member **130** (i.e., the member capable of removing the dirt off the surface of the fixing roller **110**), the cleaning blade **131** is simple in structure and can surely scrape the dirt off the surface of the fixing roller **110**. When the fixing apparatus **100** according to the present exemplary embodiment uses the cleaning pad **1150** serving as the cleaning member **130**, the cleaning pad **1150** can remove the dirt off the surface of the fixing roller **110** without damaging or abrading the surface of the fixing roller **110**. Using the clean-

ing roller **160** serving as the cleaning member **130** is advantageous in that the frictional resistance between the cleaning roller **160** and the fixing roller **110** can be reduced and the rotational torque of the fixing roller **110** can be reduced.

A fixing apparatus according to a second exemplary embodiment of the present invention is an external heating type fixing apparatus, more specifically a movable contact-type fixing apparatus that includes a heating roller heated by a heating member and moving together with the fixing roller surface. In the present exemplary embodiment, constituent members common to those of the fixing apparatus **100** according to the first exemplary embodiment are denoted by the same reference numerals.

FIG. **8** is a cross-sectional view illustrating a main portion of the fixing apparatus **100** according to the exemplary embodiment.

The fixing apparatus **100** according to the present exemplary embodiment is similar to the fixing apparatus **100** according to the first exemplary embodiment, except that a heated roller **180** operable as a rotatable heating member is employed and that a contact-sliding member **170**, the heated roller **180**, and the cleaning member **130** are differently disposed.

In the fixing apparatus **100** according to the present exemplary embodiment, the heated roller **180** includes a halogen heater **182** and an aluminum cylindrical heating pipe **181** surrounding the halogen heater **182**.

The halogen heater **182** has an elongated body extending in the longitudinal direction and held at both ends thereof by the pair of side plates **151** of the apparatus frame **150**. The halogen heater **182**, when electric power is supplied, generates radiation heat (radiation energy) and heats the heated roller **180** from the inside.

The heating pipe **181** has an elongated body extending in the longitudinal direction and held at both ends thereof by the pair of side plates **151** via bearings (not illustrated) so as to be rotatable. The heating pipe **181** has an outer circumferential surface, which contacts the surface of the fixing roller **110** to form a heating nip portion N**3** having a predetermined width between the heating pipe **181** and the fixing roller **110**. A radiant paint layer having a higher emissivity is coated on the internal cylindrical surface (inner surface) of the heating pipe **181**, so that the radiation energy emitted from the halogen heater **182** can be effectively absorbed.

The outer surface of the heating pipe **181** is covered with a PFA coating layer having excellent separation properties, which can prevent dirt from adhering on the outer surface of the heating pipe **181**. Accordingly, the heating pipe **181** heated by the halogen heater **182** is driven by the fixing roller **110** rotating in the direction indicated by the arrow R**2** and, therefore, rotates in the direction indicated by an arrow R**5**. The heating pipe **181** heats the surface of the fixing roller **110** via the heating nip portion N**3**, while the heating pipe **181** is rotating in the direction indicated by the arrow R**5**.

A temperature detection element (not illustrated) detects the temperature of the fixing roller **110**.

The contact-sliding member **170** is positioned on the upstream side of the heating nip portion N**3** and on the downstream side of the nip portion N**2** in the rotational direction R**2** of the fixing roller **110**. The contact-sliding member **170** includes a pressing member **172**, made of a SUS material, and a sliding layer **171** sliding along the surface of the fixing roller **110**. A sliding member pressing spring **173** presses the contact-sliding member **170** toward the center of the cored bar **117** of the fixing roller **110** along the direction indicated by an arrow A**5**. The material for the sliding layer **171** can be selected from fluorine resins (PFA, PTFE, FEP, etc.) having adequate separation properties. It is desired to directly provide a fluorine resin layer, serving as the sliding layer **171**, on the pressing member **172**. The sliding layer **171** can be a sheet-like member having adequate durability and surface properties. In the present exemplary embodiment, the sliding layer **171** is a PTFE-made layer (a fluorine resin layer having adequate sliding properties) configured into a sheet-like member.

When the pressing force of the sliding member pressing spring **173** is high, the offset toner and the paper dust can be easily mixed at the contact-sliding portion N**1**. However, the strong pressing force increases the frictional force between the fixing roller **110** and the contact-sliding member **170** and also increases the rotational toque of the fixing roller **110**. Therefore, it is desired that the pressing force applied by the sliding member pressing spring **173** be in the range of 5 to 200 N. In the present exemplary embodiment, the pressing force applied by the sliding member pressing spring **173** is set to 49 N. The contact-sliding portion N**1** having a width of 4.0 mm is formed.

In the state where the fixing roller **110** and the pressing roller **111** are stably rotating and the temperature of the surface of the fixing roller **110** is maintained at the predetermined fixing temperature based on an output signal from the temperature detection element, the recording material (e.g., recording paper) P carrying an unfixed toner image T reaches the nip portion N**2** along the conveyance direction A**3**. When the recording material P carrying the unfixed toner image T passes through the nip portion N**2**, the offset toner and the paper dust adhered on the surface of the fixing roller **110** are adequately mixed with each other at the contact-sliding portion N**1** between the contact-sliding member **170** and the surface of the fixing roller **110**. The offset toner and the paper dust adhered on the surface of the fixing roller **110** can reach the contact-sliding portion N**1** when the fixing roller **110** rotates in the direction indicated by the arrow R**2**.

FIG. **16** is an enlarged view illustrating the contact-sliding portion N**1** according to the present exemplary embodiment. The contact-sliding member **170** has a round surface **171***a* on the upstream side thereof in the rotational direction R**2** of the fixing roller **110**. Therefore, the inlet space S**1** is formed at the upstream end of the contact-sliding portion N**1** in the rotational direction R**2** of the fixing roller **110**. Similarly, the outlet space S**2** is formed at the downstream end of the contact-sliding portion N**1** in the rotational direction R**2** of the fixing roller **110**.

Therefore, the offset toner and the paper dust, having reached the contact-sliding portion N**1**, gradually enter the contact-sliding portion N**1**. The offset toner and the paper dust, having entered the contact-sliding portion, receive the heat from the surface of the fixing roller **110** when they pass through the contact-sliding portion N**1**. Therefore, the offset toner melts at least partly by the heat from the surface of the fixing roller **110** and is adequately mixed with the paper dust. The offset toner permeates the paper dust.

The paper dust dirt including the permeated offset toner is accumulated on the downstream side of the contact-sliding portion N**1** in the rotational direction R**2** of the fixing roller **110**. If the amount of the paper dust dirt accumulated on the downstream side of the contact-sliding portion N**1** increases due to repeated printing, the paper dust dirt is transferred to the surface of the fixing roller **110**.

The cleaning member **130** is positioned on the downstream side of the contact-sliding portion N**1** and on the upstream side of the nip portion N**2** in the rotational direction R**2** of the fixing roller **110**. In the present exemplary embodiment, the cleaning blade **131** is operable as the cleaning member **130**.

Therefore, the cleaning blade **131** scrapes the paper dust dirt, having been transferred from the contact-sliding portion N**1** to the surface of the fixing roller **110**, off the surface of the fixing roller **110**. Thus, the paper dust dirt can be surely removed from the surface of the fixing roller **110**.

A print durability test, similar to that described in the first exemplary embodiment, was conducted using the fixing apparatus **100** according to the present exemplary embodiment. In the fixing apparatus **100** according to the present exemplary embodiment, the contact-sliding portion N**1** can adequately mix the offset toner with the paper dust adhering on the surface of the fixing roller **110** and let the mixed dirt grow into a larger lump in the outlet space S**2**. The cleaning blade **131** collects the enlarged lump of the dirt. Therefore, the present exemplary embodiment can prevent the dirt from being discharged (returned) from the cleaning blade **131** to the surface of the fixing roller **110**. Thus, in the fixing apparatus **100** according to the present exemplary embodiment, no dirt was confirmed on each recording paper until the number of printed sheets reaches 100,000 corresponding to the endurance life of the fixing apparatus **100**.

The rotatable heating member usable by the fixing apparatus **100** according to the present exemplary embodiment is not limited to the heated roller **180**. For example, the rotatable heating member can be configured as a film heating type illustrated in FIG. **9**.

FIG. **9** is a cross-sectional view illustrating a main portion of the fixing apparatus **100** according to the present exemplary embodiment.

As illustrated in FIG. **9**, the film heating type rotatable heating member **180** includes a thin fixing film **191** (an endless belt), which is loosely coupled around the heater unit **112** of the fixing apparatus **100** described in the first exemplary embodiment. The fixing film **191** has an elongated body extending in longitudinal direction and held at both ends thereof by the pair of side plates **151** of the apparatus frame **150** so as to be rotatable. The pair of pressing springs **114** presses the longitudinal end portions of the heater holder **119** (the heater unit **112**) toward the fixing roller **110**.

Thus, the lower surface of the heater **113** contacts the surface of the fixing roller **110**. The pressing force of the pressing springs **114** causes the elastic layer **116** of the fixing roller **110** to elastically deform to form the heating nip portion N**3** having a predetermined width between the outer circumferential surface of the fixing film **191** and the surface of the fixing roller **110**. Accordingly, the fixing film **191** is driven by the fixing roller **110** rotating in the direction indicated by the arrow R**2** and, therefore, rotates in the direction indicated by an arrow R**10**. The heating nip portion N**3** heats the surface of the fixing roller **110**, while the fixing film **191** is rotating in the direction indicated by the arrow R**10**.

The fixing film **191** of the film heating type fixing apparatus **100** has a heat capacity smaller than that of the heated roller **180** of the above-described heated roller type fixing apparatus **100**. Therefore, the film heating type fixing apparatus **100** can reduce the rise time required to increase the temperature of the fixing film **191** to a predetermined temperature and, therefore, can reduce electric power consumption.

In the fixing apparatus **100** according to the present exemplary embodiment, the contact-sliding portion N**1** is positioned on the upstream side of the heating nip N**1** and on the downstream side of the fixing nip portion N**2** in the rotational direction R**2** of the fixing roller **110**. For example, the cleaning blade **131** can be positioned on the downstream side of the contact-sliding portion N**1** and on the upstream side of the nip portion N**2** in the rotational direction R**2** of the fixing roller **110**. In this case, the contact-sliding portion N**1** can be positioned on the downstream side of the heating nip portion N**3** and on the upstream side of the nip portion N**2** in the rotational direction R**2** of the fixing roller **110**. Functions and effects similar to those of the above-described embodiment can be obtained.

The cleaning member **130** usable in the fixing apparatus **100** according to the present exemplary embodiment is not limited to the cleaning blade **131**. For example, similar to the first exemplary embodiment, the cleaning member **130** can be the cleaning pad **1150** or the cleaning roller **160**. Similar functions and effects can be obtained.

A fixing apparatus according to a third exemplary embodiment of the present invention is an internal heating type fixing apparatus that includes a heating member configured to heat the fixing roller from the inside. In the present exemplary embodiment, constituent members common to those of the fixing apparatus **100** according to the first exemplary embodiment are denoted by the same reference numerals.

FIG. **10** is a cross-sectional view illustrating a main portion of the fixing apparatus **100** according to the present exemplary embodiment.

The fixing apparatus **100** according to the exemplary embodiment is similar to the fixing apparatus **100** according to the first exemplary embodiment in arrangement, except that a cylindrical fixing roller **200** is provided as a rotatable heating member and a halogen heater **201** is disposed in the fixing roller **200**.

The fixing roller **200** is a heated roller including a cylindrical iron pipe **202** and an elastic layer **203**. The cylindrical iron pipe **202** has an outer diameter of ϕ16 mm and a thickness of 1 mm, and has an internal space capable of accommodating the halogen heater **201**. The elastic layer **203**, which is made of a solid silicone rubber and has a thickness of 2 mm, is formed on the outer circumferential surface of the cylindrical iron pipe **202**.

The halogen heater **201** has an elongated body extending in the longitudinal direction and held at both ends thereof by the pair of side plates **151** of the apparatus frame **150**. The halogen heater **201** can generate radiation heat (radiation energy), when electric power is supplied to halogen heater **201**, to heat the fixing roller **200** from the inside.

A temperature detection element (not illustrated) detects the temperature of the fixing roller **200**.

The fixing roller **200** has an elongated body extending in the longitudinal direction and held by the pair of side plates **151** via bearings (not illustrated) so as to be rotatable. A radiant paint layer having a higher emissivity is coated on the internal cylindrical surface of the fixing roller **200** (the internal cylindrical surface of the iron pipe **202**), so that the radiation energy emitted from the halogen heater **182** can be effectively absorbed. A PFA-made layer, having excellent separation properties, is coated on the outer circumferential surface of the elastic layer **203**. The PFA-made layer can prevent the dirt from adhering on the outer surface of the elastic layer **203**.

The pressing roller **111** is positioned below the fixing roller **200** and is disposed in parallel with the fixing roller **200**. The cored bar **121** has an elongated body extending in the longitudinal direction and supported at both ends thereof by the pair of side plates **151** via the bearings **125** to as to be rotatable. The pressing springs **124**, pressing the bearings **125** in the upward direction A**2**, apply a predetermined pressing force to the pressing roller **111**. Thus, the surface of the pressing roller **111** contacts the outer circumferential surface of the fixing roller **200**. The pressing force of the pressing springs **124** causes the elastic layer **122** of the pressing roller **111** and the elastic layer **203** of the fixing roller **200** to elas-

tically deform to form the nip portion N2 having a predetermined width between the surface of the pressing roller **111** and the surface of the fixing roller **200**.

In the state where the fixing roller **200** and the pressing roller **111** are stably rotating and the temperature of the surface of the fixing roller **200** is maintained at the predetermined fixing temperature based on an output signal from the temperature detection element, the recording material carrying an unfixed toner image T reaches the nip portion N2 along the conveyance direction A3. When the recording material (e.g., recording paper) P carrying unfixed toner image T passes through the nip portion N2, the offset toner and the paper dust adhering on the surface of the fixing roller **200** are adequately mixed with each other at the contact-sliding portion N1 between the contact-sliding member **170** and the surface of the fixing roller **110**. The offset toner and the paper dust adhered on the surface of the fixing roller **200** can reach the contact-sliding portion N1 when the fixing roller **200** rotates in the direction indicated by the arrow R2.

In the present exemplary embodiment also, the inlet space and the outlet space are provided at the upstream end and the downstream end of the contact-sliding portion N1. Therefore, the offset toner and the paper dust having reached the contact-sliding portion N1 gradually enter the contact-sliding portion N1. The offset toner and the paper dust, having entered the contact-sliding portion N1, receive the heat from the surface of the fixing roller **200** and are mixed together. The offset toner, which melts at least partly by the heat from the surface of the fixing roller **200**, permeates the paper dust, while it passes through the contact-sliding portion N1.

The paper dust dirt including the permeated offset toner is accumulated on the downstream side of the contact-sliding portion N1 in the rotational direction R2 of the fixing roller **200**. If the amount of the paper dust dirt accumulated on the downstream side of the contact-sliding portion N1 increases due to repeated printing, the paper dust dirt is transferred to the surface of the fixing roller **200**.

The cleaning member **130** is positioned on the downstream side of the contact-sliding portion N1 and on the upstream side of the nip portion N2 in the rotational direction R2 of the fixing roller **200**. In the present exemplary embodiment, the cleaning blade **131** serves as the cleaning member **130**. Therefore, the cleaning blade **131** scrapes the paper dust dirt, having been transferred from the contact-sliding portion N1 to the surface of the fixing roller **200**, off the surface of the fixing roller **200**. Thus, the paper dust dirt can be surely removed from the surface of the fixing roller **200**.

A print durability test, similar to that described in the first exemplary embodiment, was conducted using the fixing apparatus **100** according to the present exemplary embodiment. In the fixing apparatus **100** according to the present exemplary embodiment, the contact-sliding portion N1 can adequately mix the offset toner with the paper dust adhering on the surface of the fixing roller **200** and let the mixed dirt grow into a larger lump in the outlet space. The cleaning blade **131** collects the enlarged lump of the dirt. Therefore, the present exemplary embodiment can prevent the dirt from being discharged (returned) from the cleaning blade **131** to the surface of the fixing roller **200**. Thus, in the fixing apparatus **100** according to the present exemplary embodiment, no dirt was confirmed on each recording paper until the number of printed sheets reaches 100,000 corresponding to the endurance life of the fixing apparatus **100**.

The cleaning member **130** usable in the fixing apparatus **100** according to the present exemplary embodiment is not limited to the cleaning blade **131**. For example, similar to the first exemplary embodiment, the cleaning member **130** can be the cleaning pad **1150** or the cleaning roller **160**. Similar functions and effects can be obtained.

FIG. **11** is a cross-sectional view illustrating a main portion of a fixing apparatus, which uses a pad member **210** serving as an example back-up member.

The back-up member usable in the fixing apparatus **100** according to the first to third exemplary embodiments is not limited to the pressing roller **111**. For example, the pad member **210** illustrated in FIG. **11** is a non-rotatable type capable of operating as the back-up member.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures, and functions.

This application claims priority from Japanese Patent Applications No. 2008-022717 filed Feb. 1, 2008 and No. 2008-330372 filed Dec. 25, 2008, which are hereby incorporated by reference herein in their entirety.

What is claimed is:

1. An image heating apparatus for heating a toner image formed on a recording medium, the image heating apparatus comprising:

a heating roller configured to contact the toner image on the recording medium to heat the toner image;

a back-up member configured to contact a surface of the heating roller to form a heating nip portion together with the heating roller, so that the recording medium is held between the heating roller and the back-up member and conveyed in a predetermined conveyance direction;

a heater having a length in a direction parallel to a generatrix of the heating roller, which is not smaller than the width of a maximum recording medium that can be processed by the image heating apparatus, and configured to contact the surface of the heating roller, wherein a contact surface of the heater contacting the surface of the heating roller is a non-movable surface, wherein an inlet space is formed between the surface of the heating roller and the contact surface of the heater on the upstream side of a contact area between the surface of the heating roller and the heater in the rotational direction of the heating roller, and an outlet space is formed between the surface of the heating roller and the contact surface of the heater on the downstream side of the contact area in the rotational direction; and

a cleaning member positioned on the downstream side of the outlet space and on the upstream side of the heating nip portion in the rotational direction and configured to contact the surface of the heating roller.

2. An image forming apparatus comprising:

an image forming unit configured to form a toner image on a recording medium; and

the image heating apparatus according to claim **1**, the image heating apparatus configured to heat the toner image on the recording medium.

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